NOTICE OF INCORPORATION

United States Legal Document

☞ All citizens and residents are hereby advised that this is a legally binding document duly incorporated by reference and that failure to comply with such requirements as hereby detailed within may subject you to criminal or civil penalties under the law. Ignorance of the law shall not excuse noncompliance and it is the responsibility of the citizens to inform themselves as to the laws that are enacted in the United States of America and in the states and cities contained therein. ☜

⁂

ASME BPVC IV (2007) (2008 Addenda), Boiler & Pressure Vessel Code, Rules for Construction of Heating Boilers, as required by the States of Alaska, Arizona, California, Illinois, Iowa, Kansas, Michigan, Missouri, Nebraska, New Hampshire, New Jersey, North Dakota, Ohio, Oregon, Utah, Wisconsin, et. alia.

AN INTERNATIONAL CODE

2007 ASME Boiler & Pressure Vessel Code

2008a Addenda July 1, 2008

IV

RULES FOR CONSTRUCTION OF HEATING BOILERS

ASME Boiler and Pressure Vessel Committee
Subcommittee on Heating Boilers

The American Society of Mechanical Engineers

ASME
SETTING THE STANDARD

U040W8

Date of Issuance: July 1, 2008

This international code or standard was developed under procedures accredited as meeting the criteria for American National Standards and it is an American National Standard. The Standards Committee that approved the code or standard was balanced to assure that individuals from competent and concerned interests have had an opportunity to participate. The proposed code or standard was made available for public review and comment that provides an opportunity for additional public input from industry, academia, regulatory agencies, and the public-at-large.

ASME does not "approve," "rate," or "endorse" any item, construction, proprietary device, or activity.

ASME does not take any position with respect to the validity of any patent rights asserted in connection with any items mentioned in this document, and does not undertake to insure anyone utilizing a standard against liability for infringement of any applicable letters patent, nor assume any such liability. Users of a code or standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, is entirely their own responsibility.

Participation by federal agency representative(s) or person(s) affiliated with industry is not to be interpreted as government or industry endorsement of this code or standard.

ASME accepts responsibility for only those interpretations of this document issued in accordance with the established ASME procedures and policies, which precludes the issuance of interpretations by individuals.

The footnotes in this document are part of this American National Standard.

The Specifications published and copyrighted by the American Society for Testing and Materials are reproduced with the Society's permission.

No part of this document may be reproduced in any form, in an electronic retrieval system or
otherwise, without the prior written permission of the publisher.

Library of Congress Catalog Card Number: 56-3934
Printed in the United States of America

The American Society of Mechanical Engineers
Three Park Avenue, New York, NY 10016-5990

Copyright © 2008 by
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
All rights reserved

SUMMARY OF CHANGES

Addenda to the 2007 Edition of the Code are issued in the form of replacement pages. Revisions, additions, or deletions are incorporated directly into the affected pages. It is advisable, however, that all replaced pages be retained for reference.

Replace or insert the pages listed. Changes given below are identified on the pages by a margin note, **A08**, placed next to the affected area. Revisions to the 2007 Edition are indicated by **07**. For the listing below, the *Page* references the affected area. A margin note, **A08**, placed next to the heading indicates *Location.* Revisions are listed under *Change.*

The Record Numbers listed below are explained in more detail in "List of Changes in Record Number Order" following the Summary of Changes.

Page	*Location*	*Change (Record Number)*
xix–xxix	Roster	Updated to reflect 2008 Addenda
xxxi	ASTM Roster	Updated to reflect 2008 Addenda
5, 6	HG-307.1(a)	Nomenclature for Z corrected by errata *(07-537)*
36	HG-402.1	(1) Sentence added to start the second paragraph *(06-1435)* (2) Subparagraph (b) deleted in its entirety *(06-1435)*
46	HG-530.1(a)(3)	Second reference corrected by errata *(07-537)*
48	HG-530.2(b)(3)	Both references corrected by errata *(07-537)*
52	HG-603(d)	Last line revised *(05-532)*
53–54.1	HG-605	(1) First paragraph revised *(05-532)* (2) Subparagraph (c) revised in its entirety *(05-532)*
	HG-606(a)	Revised *(05-532)*
	HG-613	In the first paragraph, second sentence added *(05-532)*
	HG-614(a)	Revised *(05-532)*
57, 60	HG-705	(1) The last sentence in subparas. (a) and (b) revised *(07-114)* (2) Subparagraph (c) added *(07-114)*
	HG-709.2	SI equation revised *(07-1232)*
77–81	Table HF-300.2	Revised *(06-398, 06-78, 06-1628, 07-110)*
82–82.4	Table HF-300.2M	Revised *(06-398, 06-78, 06-1628, 07-110)*
120	HC-311.1(b)(2)(a)	In eq. (l), "t" corrected to "T" by errata *(07-537)*
127	HA-201(b)(2)(g)	Reference corrected by errata *(07-537)*
133, 134	HA-502.12.2	(1) Last two subparagraphs redesignated as (d) and (e), respectively *(07-537)* (2) In subparas. (d) and (e), references corrected by errata *(07-537)*
	HA-503	Reference corrected by errata *(07-537)*
	HA-504(b)	Reference corrected by errata *(07-537)*
137	HLW-101.2(c)	Revised *(07-187)*

Page	*Location*	*Change (Record Number)*
143, 144	Table HLW-300	(1) Title revised *(07-538)* (2) SA-278 added under Castings *(05-1413)* (3) Note (10) added *(05-1413)*
145, 146	Table HLW-301	Title revised *(07-538)*
175	Table 2-100	UL-353 added *(05-532)*
186, 186.1	E-100	Definition of *boiler modular* revised *(05-532)*
196, 196.1	Nonmandatory Appendix K	Under "H Code Symbol Stamp," items 11 through 14 added *(07-112)*
200–202	Instructions for Data Report Forms	New column H-5A added *(07-112)*
211	Form H-5A	Items 5 and 8 revised *(07-112)*
225	M-3	In the in-text table, factor for Btu/hr corrected by errata to read "0.2930711" *(07-537)*

NOTE:

Volume 58 of the Interpretations to Section IV of the ASME Boiler and Pressure Vessel Code follows the last page of this Addenda.

LIST OF CHANGES IN RECORD NUMBER ORDER

Record Number	Change
05-1413	Addition of Gray Iron Castings SA-278, Classes 20, 25, 30, 35, and 40 into Table HLW-300.
05-532	Addition of requirements to HG-605, HG-606, HG-613, and HG-614 to require compliance with UL353, Standard for Limit Controls, and acceptance by a nationally recognized testing agency. Addition of requirements in HG-605 for mounting of pressure controls with extended piping. Revision of HG-603(d) with respect to level of water visible in gage glass and actuation of cutoff device. Revision of definition of "boiler, modular." Addition of UL 353 to the list of UL Standards found in Mandatory Appendix 2.
06-1435	HG-402.1(b) deleted since it is in conflict with the requirements under HG-102. Cross reference to HG-102 added in HG-402.1 to give guidance on selection of alternative nameplate units.
06-1628	Addition of the following material specification alloys to Tables HF-300.2 and HF-300.2M for the class/condition/temper listed in the table: SB-42 copper alloys (C12000 and C12200) SB-75 copper alloys (C12000 and C12200) SB-111 copper alloys (C12000, C12200, and C14200) SB-152 copper alloys (C10400, C10500, C10700, C11000, C12200, C12300, and C14200) SB-395 copper alloys (C12000, C12200, and C14200)
06-398	Addition of materials SB-435 (plate, sheet, and strip), SB-572 [rod (bar)], SB-564 (forgings), SB-366 (fittings), SB-619 (welded pipe), SB-622 (seamless pipe & tube), and SB-626 (welded pipe) into Tables HF-300.2 and HF-300.2M of the Section IV Code book.
06-78	Addition of materials SB-209, SB-210, SB-211, SB-221, and SB-241 to Tables HF-300.2 and HF-300.2M.
07-110	Addition of SB-210 Aluminum Alloys, UNS A93003-O and A96061-T6 in Tables HF-300.2 and HF-300.2M under new Aluminum subpart.
07-112	Addition of four new Code Symbol Stamp Scope Statements (11, 12, 13, and 14) under Nonmandatory Appendix K, which cover cast aluminum heating boilers. Addition of column for H-5A master data report form along with appropriate instructions for completion into Nonmandatory Appendix L. Additionally, two new instructions (Notes 76 and 77) related to boilers constructed primarily of cast aluminum have been added to Nonmandatory Appendix L. Form H-5A has been revised by the addition of new instructions found in Nonmandatory Appendix L (Notes 76 and 77).
07-114	Last sentence of HG-705(a) has been revised in order to clarify the existing requirements. Last sentence of HG-705(b) has been revised in order to clarify the existing requirements. Addition of new requirements covering temperature rating has been added as HG-705(c).
07-1232	SI units formula under HG-709.2 has been corrected as follows: $V_t = [(0.000738T - 0.03348)V_s]/[(P_a/P_f) - (P_a/P_o)]$
07-187	In HLW-101.2(c),"L" replaced with lowercase "l" and "HLW-700 and" inserted before "HW-800."
07-537	Errata correction.
07-538	Revision of Table HLW-300 by adding "WATER HEATER" after "FOR LINED MATERIALS." Revision of Table HLW-301 by deleting "FOR MATERIALS" and adding "MATERIALS" after "WATER HEATER."

INTENTIONALLY LEFT BLANK

PERSONNEL

A08

ASME Boiler and Pressure Vessel Committee
Subcommittees, Subgroups, and Working Groups

As of January 1, 2008

MAIN COMMITTEE

J. G. Feldstein, *Chair*
T. P. Pastor, *Vice Chair*
J. S. Brzuszkiewicz, *Staff Secretary*
R. W. Barnes
R. J. Basile
J. E. Batey
D. L. Berger
M. N. Bressler
D. A. Canonico
R. P. Deubler
D. A. Douin
R. E. Gimple
M. Gold
T. E. Hansen
C. L. Hoffmann
G. G. Karcher
D. F. Landers
W. M. Lundy
J. R. MacKay
U. R. Miller
P. A. Molvie
C. C. Neely
W. E. Norris
G. C. Park
M. D. Rana
B. W. Roberts
F. J. Schaaf, Jr.
A. Selz
R. W. Swayne
D. E. Tanner
F. B. Kovacs, *Alternate*
K. Oyamada, *Delegate*
T. Tahara, *Delegate*

EXECUTIVE COMMITTEE (MAIN COMMITTEE)

T. P. Pastor, *Chair*
J. G. Feldstein, *Vice Chair*
J. S. Brzuszkiewicz, *Staff Secretary*
R. W. Barnes
D. L. Berger
P. D. Edwards
M. Gold
G. G. Karcher
G. C. Park
A. Selz
D. E. Tanner

HONORARY MEMBERS (MAIN COMMITTEE)

F. P. Barton
R. D. Bonner
R. J. Bosnak
R. J. Cepluch
L. J. Chockie
T. M. Cullen
W. D. Doty
J. R. Farr
G. E. Feigel
R. C. Griffin
O. F. Hedden
E. J. Hemzy
M. H. Jawad
A. J. Justin
E. L. Kemmler
W. G. Knecht
J. LeCoff
T. G. McCarty
G. C. Millman
R. A. Moen
R. F. Reedy
W. E. Somers
K. K. Tam
L. P. Zick, Jr.

HONORS AND AWARDS COMMITTEE

M. Gold, *Chair*
F. E. Gregor, *Vice Chair*
D. R. Sharp, *Staff Secretary*
R. J. Basile
J. E. Batey
D. L. Berger
J. G. Feldstein
W. L. Haag, Jr.
S. F. Harrison, Jr.
R. M. Jessee
W. C. LaRochelle
T. P. Pastor
A. Selz
R. R. Stevenson

MARINE CONFERENCE GROUP

H. N. Patel, *Chair*
L. W. Douthwaite
P. E. Little
R. J. Petow

CONFERENCE COMMITTEE

D. A. Douin — Illinois *(Chair)*
R. D. Reetz — North Dakota *(Vice Chair)*
D. E. Tanner — Ohio *(Secretary)*
R. J. Aben, Jr. — Michigan
J. S. Aclaro — California
A. E. Adkins — West Virginia
J. T. Amato — Minnesota
E. A. Anderson — Illinois
F. R. Andrus — Oregon
B. P. Anthony — Rhode Island
R. D. Austin — Arizona
E. W. Bachellier — Nunavut, Canada
M. M. Barber — Michigan
R. W. Bartlett — Arizona
F. P. Barton — Virginia
M. Bishop — British Columbia, Canada
L. Blair — Nebraska
W. K. Brigham — New Hampshire
D. E. Burns — Nebraska
J. H. Burpee — Maine
C. J. Castle — Nova Scotia, Canada
D. C. Cook — California
R. A. Coomes — Kentucky
D. Eastman — Newfoundland and Labrador, Canada
G. L. Ebeyer — Louisiana
E. Everett — Georgia
J. M. Given, Jr. — North Carolina
J. E. Guerra — Arizona
R. J. Handy — Kentucky
J. B. Harlan — Delaware
K. Hynes — Prince Edward Island, Canada
D. T. Jagger — Ohio
D. J. Jenkins — Kansas
A. P. Jones — Texas
S. Katz — British Columbia, Canada
M. R. Klosterman — Iowa
M. Kotb — Quebec, Canada
B. Krasiun — Saskatchewan, Canada
K. T. Lau — Alberta, Canada
M. A. Malek — Florida
G. F. Mankel — Nevada
R. D. Marvin II — Washington
I. W. Mault — Manitoba, Canada
H. T. McEwen — Mississippi

CONFERENCE COMMITTEE (CONT'D)

T. J. Monroe — Oklahoma
M. F. Mooney — Massachusetts
F. Musuta — Ontario, Canada
G. R. Myrick — Arkansas
Y. Nagpaul — Hawaii
W. R. Owens — Louisiana
T. M. Parks — Ohio
R. P. Pate — Alabama
J. D. Payton — Pennsylvania
M. R. Peterson — Alaska
H. D. Pfaff — South Dakota
J. L. Pratt — Missouri
D. C. Price — Yukon Territory, Canada
R. S. Pucek — Wisconsin
M. D. Ramirez — Florida
D. E. Ross — New Brunswick, Canada
K. A. Rudolph — Hawaii
G. Scribner — Missouri
R. K. Sturm — Utah
N. Surtees — Saskatchewan, Canada
M. R. Toth — Tennessee
M. J. Verhagen — Wisconsin
P. L. Vescio, Jr. — New York
M. Washington — New Jersey
K. L. Watson — Mississippi
R. B. West — Iowa
M. J. Wheel — Vermont
D. J. Willis — Indiana
E. Zarate — Arizona

BPV PROJECT TEAM ON HYDROGEN TANKS

M. D. Rana, *Chair*
G. M. Eisenberg, *Staff Secretary*
F. L. Brown
D. A. Canonico
D. C. Cook
J. W. Felbaum
B. D. Hawkes
T. Joseph
N. L. Newhouse
G. B. Rawls, Jr.
B. F. Shelley
J. R. Sims, Jr.
N. Sirosh
J. H. Smith
S. Staniszewski
T. Tahara
D. W. Treadwell
E. Upitis
C. T. L. Webster
L. Wolpert
R. C. Biel, *Contributing Member*
J. Birdsall, *Contributing Member*
J. Cameron, *Contributing Member*
M. Duncan, *Contributing Member*
D. R. Frikken, *Contributing Member*
L. E. Hayden, Jr., *Contributing Member*
K. T. Lau, *Contributing Member*
K. Oyamada, *Contributing Member*
C. H. Rivkin, *Contributing Member*
C. San Marchi, *Contributing Member*
B. Somerday, *Contributing Member*

INTERNATIONAL INTEREST REVIEW GROUP

V. Felix
Y.-G. Kim
W. Lin
O. F. Manafa
C. Minu
Y.-W. Park
R. Reynaga
P. Williamson

SUBCOMMITTEE ON POWER BOILERS (SC I)

D. L. Berger, *Chair*
B. W. Roberts, *Vice Chair*
U. D'Urso, *Staff Secretary*
S. W. Cameron
D. A. Canonico
K. K. Coleman
P. D. Edwards
J. G. Feldstein
J. D. Fishburn
T. E. Hansen
J. F. Henry
J. S. Hunter
C. F. Jeerings
J. P. Libbrecht
W. L. Lowry
J. R. MacKay
F. Massi
T. C. McGough
R. E. McLaughlin
P. A. Molvie
Y. Oishi
J. T. Pillow
R. D. Schueler, Jr.
J. P. Swezy, Jr.
J. M. Tanzosh
R. V. Wielgoszinski
D. J. Willis
G. Ardizzoia, *Delegate*

Honorary Members (SC I)

D. N. French
W. E. Somers
R. L. Williams

Subgroup on Design (SC I)

P. A. Molvie, *Chair*
G. L. Hiler, *Secretary*
J. D. Fishburn
J. P. Glaspie
C. F. Jeerings
G. B. Komora
J. P. Libbrecht
J. C. Light
B. W. Moore
R. D. Schueler, Jr.
J. L. Seigle
J. P. Swezy, Jr.
S. V. Torkildson
J. Vattappilly
G. Ardizzoia, *Delegate*

Subgroup on Fabrication and Examination (SC I)

J. T. Pillow, *Chair*
G. W. Galanes, *Secretary*
J. L. Arnold
D. L. Berger
S. W. Cameron
J. Hainsworth
T. E. Hansen
C. T. McDaris
T. C. McGough
R. E. McLaughlin
Y. Oishi
J. P. Swezy, Jr.
R. V. Wielgoszinski

Subgroup on General Requirements (SC I)

R. E. McLaughlin, *Chair*
F. Massi, *Secretary*
G. Cook
P. D. Edwards
T. E. Hansen
W. L. Lowry
T. C. McGough
E. M. Ortman
J. T. Pillow
D. Tompkins
S. V. Torkildson
R. V. Wielgoszinski
D. J. Willis

Subgroup on Materials (SC I)

B. W. Roberts, *Chair*
J. S. Hunter, *Secretary*
D. A. Canonico
K. K. Coleman
P. Fallouey
J. D. Fishburn
G. W. Galanes
K. L. Hayes
J. F. Henry
J. P. Libbrecht
J. R. MacKay
F. Masuyama
J. M. Tanzosh

Subgroup on Piping (SC I)

T. E. Hansen, *Chair*
D. Tompkins, *Secretary*
D. L. Berger
P. D. Edwards
G. W. Galanes
W. L. Lowry
F. Massi
T. C. McGough
E. A. Whittle

Heat Recovery Steam Generators Task Group (SC I)

T. E. Hansen, *Chair*
E. M. Ortman, *Secretary*
R. W. Anderson
J. P. Bell
L. R. Douglas
J. D. Fishburn
G. B. Komora
J. P. Libbrecht
D. L. Marriott
B. W. Moore
A. L. Plumley
R. D. Schueler, Jr.
J. C. Steverman, Jr.
S. R. Timko
D. Tompkins
S. V. Torkildson
B. C. Turczynski
E. A. Turhan

SUBCOMMITTEE ON MATERIALS (SC II)

J. F. Henry, *Chair*
M. Gold, *Vice Chair*
N. Lobo, *Staff Secretary*
F. Abe
D. C. Agarwal
W. R. Apblett, Jr.
A. Appleton
M. N. Bressler
H. D. Bushfield
J. Cameron
D. A. Canonico
A. Chaudouet
P. Fallouey
D. W. Gandy
M. H. Gilkey
J. F. Grubb
C. L. Hoffmann
M. Katcher
P. A. Larkin
F. Masuyama
R. K. Nanstad
M. L. Nayyar
E. G. Nisbett
D. W. Rahoi
B. W. Roberts
E. Shapiro
M. H. Skillingberg
R. C. Sutherlin
R. W. Swindeman
J. M. Tanzosh
B. E. Thurgood
D. Kwon, *Delegate*
O. Oldani, *Delegate*

Honorary Members (SC II)

A. P. Ahrendt
T. M. Cullen
R. Dirscherl
W. D. Doty
W. D. Edsall
J. J. Heger
G. C. Hsu
R. A. Moen
C. E. Spaeder, Jr.
A. W. Zeuthen

Subgroup on External Pressure (SC II & SC-D)

R. W. Mikitka, *Chair*
J. A. A. Morrow, *Secretary*
L. F. Campbell
D. S. Griffin
J. F. Grubb
M. Katcher
D. L. Kurle
E. Michalopoulos
D. Nadel
C. H. Sturgeon

Subgroup on Ferrous Specifications (SC II)

E. G. Nisbett, *Chair*
A. Appleton, *Vice Chair*
R. M. Davison
B. M. Dingman
M. J. Dosdourian
T. Graham
J. F. Grubb
K. M. Hottle
D. S. Janikowski
D. C. Krouse
L. J. Lavezzi
W. C. Mack
J. K. Mahaney
R. J. Marciniec
A. S. Melilli
K. E. Orie
E. Upitis
R. Zawierucha
A. W. Zeuthen

Subgroup on International Material Specifications (SC II)

W. M. Lundy, *Chair*
A. Chaudouet, *Vice Chair*
D. Dziubinski, *Secretary*
D. C. Agarwal
H. D. Bushfield
D. A. Canonico
P. Fallouey
A. F. Garbolevsky
D. O. Henry
M. Higuchi
H. Lorenz
A. R. Nywening
R. D. Schueler, Jr.
E. Upitis
D. Kwon, *Delegate*
O. Oldani, *Delegate*

Subgroup on Nonferrous Alloys (SC II)

M. Katcher, *Chair*
R. C. Sutherlin, *Secretary*
D. C. Agarwal
W. R. Apblett, Jr.
H. D. Bushfield
M. H. Gilkey
J. F. Grubb
A. Heino
G. C. Hsu
J. Kissell
P. A. Larkin
H. Matsuo
J. A. McMaster
D. T. Peters
D. W. Rahoi
E. Shapiro
M. H. Skillingberg
D. Tyler
R. Zawierucha

Subgroup on Strength, Ferrous Alloys (SC II)

C. L. Hoffmann, *Chair*
J. M. Tanzosh, *Secretary*
F. Abe
W. R. Apblett, Jr.
D. A. Canonico
K. K. Coleman
P. Fallouey
M. Gold
J. F. Henry
K. Kimura
F. Masuyama
H. Matsuo
H. Murakami
D. W. Rahoi
B. W. Roberts
M. S. Shelton
J. P. Shingledecker
R. W. Swindeman
B. E. Thurgood
T. P. Vassallo, Jr.

Subgroup on Physical Properties (SC II)

J. F. Grubb, *Chair*
D. C. Agarwal
H. D. Bushfield
P. Fallouey
E. Shapiro

Subgroup on Strength of Weldments (SC II & SC IX)

J. M. Tanzosh, *Chair*
W. F. Newell, Jr., *Secretary*
K. K. Coleman
P. D. Flenner
D. W. Gandy
K. L. Hayes
J. F. Henry
D. W. Rahoi
B. W. Roberts
J. P. Shingledecker
W. J. Sperko
B. E. Thurgood

Subgroup on Toughness (SC II & SC VIII)

W. S. Jacobs, *Chair*
J. L. Arnold
R. J. Basile
J. Cameron
H. E. Gordon
D. C. Lamb
K. Mokhtarian
C. C. Neely
T. T. Phillips
M. D. Rana
F. L. Richter
D. A. Swanson
E. Upitis
K. Oyamada, *Delegate*

Special Working Group on Nonmetallic Materials (SC II)

C. W. Rowley, *Chair*
F. L. Brown
S. R. Frost
M. Golliet
P. S. Hill
M. R. Kessler
J. W. Wegner
F. Worth

SUBCOMMITTEE ON NUCLEAR POWER (SC III)

R. W. Barnes, *Chair*
R. M. Jessee, *Vice Chair*
C. A. Sanna, *Staff Secretary*
W. H. Borter
M. N. Bressler
T. D. Burchell
J. R. Cole
R. E. Cornman, Jr.
R. P. Deubler
B. A. Erler
G. M. Foster
R. S. Hill III
C. L. Hoffmann
C. C. Kim
V. Kostarev
D. F. Landers
W. C. LaRochelle
K. A. Manoly
E. A. Mayhew
W. N. McLean
M. N. Mitchell
D. K. Morton
O. O. Oyamada
R. F. Reedy
B. B. Scott
J. D. Stevenson
K. R. Wichman
Y. H. Choi, *Delegate*
T. Ius, *Delegate*

Honorary Members (SC III)

R. J. Bosnak
E. B. Branch
W. D. Doty
F. R. Drahos
R. A. Moen
C. J. Pieper

Subgroup on Containment Systems for Spent Fuel and High-Level Waste Transport Packagings (SC III)

G. M. Foster, *Chair*
G. J. Solovey, *Vice Chair*
D. K. Morton, *Secretary*
G. Bjorkman
W. H. Borter
G. R. Cannell
E. L. Farrow
J. L. Gorczyca
R. S. Hill III
D. W. Lewis
C. G. May
P. E. McConnell
I. D. McInnes
A. B. Meichler
R. E. Nickell
E. L. Pleins
T. Saegusa
H. P. Shrivastava
N. M. Simpson
R. H. Smith
J. D. Stevenson
C. J. Temus
A. D. Watkins

Subgroup on Design (SC III)

R. P. Deubler, *Chair*
R. S. Hill III, *Vice Chair*
A. N. Nguyen, *Secretary*
T. M. Adams
M. N. Bressler
C. W. Bruny
D. L. Caldwell
J. R. Cole
R. E. Cornman, Jr.
A. A. Dermenjian
P. Hirschberg
R. I. Jetter
R. B. Keating
J. F. Kielb
H. Kobayashi
D. F. Landers
K. A. Manoly
R. J. Masterson
W. N. McLean
J. C. Minichiello
M. Morishita
F. F. Naguib
T. Nakamura
E. L. Pleins
I. Saito
G. C. Slagis
J. D. Stevenson
J. P. Tucker
K. R. Wichman
T. Ius, *Delegate*

Working Group on Supports (SG-D) (SC III)

R. J. Masterson, *Chair*
F. J. Birch, *Secretary*
U. S. Bandyopadhyay
R. P. Deubler
W. P. Golini
A. N. Nguyen
I. Saito
J. R. Stinson
T. G. Terryah
D. V. Walshe
C.-I. Wu

Working Group on Core Support Structures (SG-D) (SC III)

J. F. Kielb, *Chair*
F. G. Al-Chammas
J. T. Land
J. F. Mullooly

Working Group on Design Methodology (SG-D)

R. B. Keating, *Chair*
M. K. Au-Yang
M. Basol
R. D. Blevins
D. L. Caldwell
H. T. Harrison III
M. Hartzman
P. Hirschberg
H. Kobayashi
D. F. Landers
W. S. Lapay
H. Lockert
J. F. McCabe
A. N. Nguyen
S. Snow
J. D. Stevenson
T. M. Wiger
J. Yang

Working Group on Design of Division 3 Containments (SG-D) (SC III)

E. L. Pleins, *Chair*
G. Bjorkman
J. L. Gorczyca
D. W. Lewis
I. D. McInnes
J. C. Minichiello
D. K. Morton
R. E. Nickell
H. P. Shrivastava
C. J. Temus

Working Group on Piping (SG-D) (SC III)

P. Hirschberg, *Chair*
R. C. Fung, *Secretary*
G. A. Antaki
C. Basavaraju
J. Catalano
J. R. Cole
R. J. Gurdal
R. W. Haupt
J. Kawahata
R. B. Keating
V. Kostarev
D. F. Landers
J. F. McCabe
J. C. Minichiello
A. N. Nguyen
R. D. Patel
E. C. Rodabaugh
N. J. Shah
M. S. Sills
G. C. Slagis
E. A. Wais
C.-I. Wu

Working Group on Probabilistic Methods in Design (SG-D) (SC III)

R. S. Hill III, *Chair*
T. Asayama
B. M. Ayyub
T. A. Bacon
C. Basavaraju
A. A. Dermenjian
M. R. Graybeal
D. O. Henry
S. D. Kulat
A. McNeill III
P. J. O'Regan
N. A. Palm
I. Saito
M. E. Schmidt
J. P. Tucker
R. M. Wilson

Working Group on Pumps (SG-D) (SC III)

R. E. Cornman, Jr., *Chair*
M. D. Eftychiou
A. A. Fraser
R. Ghanbari
M. Higuchi
C. J. Jerz
J. W. Leavitt
J. E. Livingston
J. R. Rajan
A. G. Washburn

Working Group on Valves (SG-D) (SC III)

J. P. Tucker, *Chair*
G. A. Jolly
W. N. McLean
T. A. McMahon
J. D. Page
S. N. Shields
H. R. Sonderegger
J. C. Tsacoyeanes

Working Group on Vessels (SG-D) (SC III)

F. F. Naguib, *Chair*
G. K. Miller, *Secretary*
C. W. Bruny
G. D. Cooper
M. Hartzman
W. J. Heilker
A. Kalnins
R. B. Keating
K. Matsunaga
D. E. Matthews
M. Nakahira
R. M. Wilson

Special Working Group on Environmental Effects (SG-D) (SC III)

W. Z. Novak, *Chair*
R. S. Hill III
C. L. Hoffmann
Y. H. Choi, *Delegate*

Subgroup on General Requirements (SC III & SC 3C)

W. C. LaRochelle, *Chair*
A. Appleton, *Secretary*
J. R. Berry
J. V. Gardiner
W. P. Golini
G. L. Hollinger
C. A. Lizotte
E. A. Mayhew
R. P. McIntyre
R. D. Mile
M. R. Minick
B. B. Scott
H. K. Sharma
W. K. Sowder, Jr.
D. M. Vickery
D. V. Walshe
H. Michael, *Delegate*

Subgroup on Materials, Fabrication, and Examination (SC III)

C. L. Hoffmann, *Chair*
G. P. Milley, *Secretary*
W. H. Borter
D. M. Doyle
G. M. Foster
G. B. Georgiev
R. M. Jessee
C. C. Kim
M. Lau
H. Murakami
M. Nakahira
N. M. Simpson
W. J. Sperko
J. R. Stinson
K. B. Stuckey
A. D. Watkins
H. Michael, *Delegate*

Subgroup on Pressure Relief (SC III)

S. F. Harrison, Jr., *Chair*
J. F. Ball
E. M. Petrosky
A. L. Szeglin
D. G. Thibault

Subgroup on Strategy and Management (SC III, Divisions 1 and 2)

R. W. Barnes, *Chair*
C. A. Sanna, *Staff Secretary*
J. R. Cole, *Secretary*
B. K. Bobo
N. Broom
B. A. Erler
C. M. Faidy
J. M. Helmey
M. F. Hessheimer
R. S. Hill III
E. V. Imbro
R. M. Jessee
R. F. Reedy
Y. Urabe

Special Working Group on Editing and Review (SC III)

R. F. Reedy, *Chair*
W. H. Borter
M. N. Bressler
D. L. Caldwell
R. P. Deubler
B. A. Erler
W. C. LaRochelle
J. D. Stevenson

Special Working Group on Polyethylene Pipe (SC III)

D. F. Landers, *Chair*
J. C. Minichiello, *Secretary*
T. M. Adams
G. A. Antaki
C. Basavaraju
D. Burwell
J. M. Craig
R. R. Croft
M. Golliet
P. Krishnaswamy
K. A. Manoly
E. W. McElroy
D. P. Munson
L. J. Petroff
C. W. Rowley
F. J. Schaaf, Jr.
D. M. Vickery

Subgroup on Graphite Core Components (SC III)

T. D. Burchell, *Chair*
C. A. Sanna, *Staff Secretary*
R. L. Bratton
S.-H. Chi
M. W. Davies
S. W. Doms
S. F. Duffy
O. Gelineau
G. O. Hayner
M. P. Hindley
M. N. Mitchell
N. N. Nemeth
T. Oku
T. Shibata
M. Srinivasan

JOINT ACI-ASME COMMITTEE ON CONCRETE COMPONENTS FOR NUCLEAR SERVICE (SC 3C)

T. C. Inman, *Chair*
A. C. Eberhardt, *Vice Chair*
C. A. Sanna, *Staff Secretary*
N. Alchaar
T. D. Al-Shawaf
J. F. Artuso
H. G. Ashar
B. A. Erler
F. Farzam
P. S. Ghosal
J. Gutierrez
J. K. Harrold
G. A. Harstead
M. F. Hessheimer
T. E. Johnson
O. Jovall
N.-H. Lee
B. B. Scott
R. E. Shewmaker
J. D. Stevenson
A. Y. C. Wong
M. R. Senecal, *Contributing Member*

SUBCOMMITTEE ON HEATING BOILERS (SC IV)

P. A. Molvie, *Chair*
G. Moino, *Staff Secretary*
T. L. Bedeaux
J. Calland
J. P. Chicoine
C. M. Dove
W. L. Haag, Jr.
J. A. Hall
D. J. Jenkins
K. M. McTague
B. W. Moore
E. A. Nordstrom
T. M. Parks
J. L. Seigle
R. V. Wielgoszinski
F. P. Barton, *Honorary Member*
R. H. Weigel, *Honorary Member*
H. Michael, *Delegate*

Subgroup on Care and Operation of Heating Boilers (SC IV)

T. L. Bedeaux
K. M. McTague
P. A. Molvie

Subgroup on Cast Iron Boilers (SC IV)

K. M. McTague, *Chair*
T. L. Bedeaux
J. P. Chicoine
B. G. French
J. A. Hall
A. P. Jones
V. G. Kleftis
J. Kliess
P. A. Larkin
E. A. Nordstrom

Subgroup on Materials (SC IV)

P. A. Larkin, *Chair*
J. A. Hall
A. Heino
J. Kliess
J. L. Seigle

Subgroup on Water Heaters (SC IV)

W. L. Haag, Jr., *Chair*
J. Calland
B. G. French
T. D. Gantt
A. P. Jones
K. M. McTague
O. A. Missoum
F. J. Schreiner
M. A. Taylor
T. E. Trant

Subgroup on Welded Boilers (SC IV)

T. L. Bedeaux, *Chair*
J. Calland
C. M. Dove
B. G. French
A. P. Jones
E. A. Nordstrom
J. L. Seigle
R. V. Wielgoszinski
H. Michael, *Delegate*

SUBCOMMITTEE ON NONDESTRUCTIVE EXAMINATION (SC V)

J. E. Batey, *Chair*
F. B. Kovacs, *Vice Chair*
S. Vasquez, *Staff Secretary*
S. J. Akrin
J. E. Aycock
M. M. Barber
A. S. Birks
P. L. Brown
N. Y. Faransso
A. F. Garbolevsky
G. W. Hembree
R. W. Kruzic
F. J. Sattler
B. H. Clark, Jr., *Honorary Member*
H. C. Graber, *Honorary Member*
O. F. Hedden, *Honorary Member*
J. R. MacKay, *Honorary Member*
T. G. McCarty, *Honorary Member*
G. M. Gatti, *Delegate*

Subgroup on General Requirements/ Personnel Qualifications and Inquiries (SC V)

F. B. Kovacs, *Chair*
J. E. Batey
A. S. Birks
N. Y. Faransso
G. W. Hembree
J. W. Houf
J. R. MacKay
J. P. Swezy, Jr.

Subgroup on Surface Examination Methods (SC V)

A. S. Birks, *Chair*
S. J. Akrin
P. L. Brown
N. Y. Faransso
N. A. Finney
G. W. Hembree
R. W. Kruzic
F. J. Sattler
G. M. Gatti, *Delegate*

Subgroup on Volumetric Methods (SC V)

G. W. Hembree, *Chair*
S. J. Akrin
J. E. Aycock
J. E. Batey
P. L. Brown
N. Y. Faransso
A. F. Garbolevsky
R. W. Hardy
R. A. Kellerhall
F. B. Kovacs
R. W. Kruzic
A. B. Nagel
F. J. Sattler
G. M. Gatti, *Delegate*

Working Group on Acoustic Emissions (SG-VM) (SC V)

N. Y. Faransso, *Chair*
J. E. Aycock
J. E. Batey

Working Group on Radiography (SG-VM) (SC V)

F. B. Kovacs, *Chair*
S. J. Akrin
J. E. Aycock
J. E. Batey
P. L. Brown
N. Y. Faransso
A. F. Garbolevsky
R. W. Hardy
G. W. Hembree
R. W. Kruzic
R. J. Mills
A. B. Nagel
T. L. Plasek
D. E. Williams

Working Group on Ultrasonics (SG-VM) (SC V)

R. W. Kruzic, *Chair*
J. E. Aycock
N. Y. Faransso
N. A. Finney
O. F. Hedden
R. A. Kellerhall
M. D. Moles
A. B. Nagel
F. J. Sattler

SUBCOMMITTEE ON PRESSURE VESSELS (SC VIII)

T. P. Pastor, *Chair*
U. R. Miller, *Vice Chair*
S. J. Rossi, *Staff Secretary*
D. R. Sharp, *Staff Secretary*
R. J. Basile
J. Cameron
D. B. Demichael
J. P. Glaspie
M. Gold
W. S. Jacobs
G. G. Karcher
K. T. Lau
J. S. Lee
R. Mahadeen
S. Malone
R. W. Mikitka
K. Mokhtarian
C. C. Neely
T. W. Norton
D. T. Peters
M. J. Pischke
M. D. Rana
G. B. Rawls, Jr.
S. C. Roberts
C. D. Rodery
A. Selz
J. R. Sims, Jr.
K. K. Tam
E. Upitis
E. L. Thomas, Jr., *Honorary Member*
H. Michael, *Delegate*
K. Oyamada, *Delegate*
M. Papponetti, *Delegate*

Subgroup on Design (SC VIII)

U. R. Miller, *Chair*
M. D. Lower, *Secretary*
O. A. Barsky
R. J. Basile
M. R. Breach
F. L. Brown
J. R. Farr
C. E. Hinnant
W. S. Jacobs
R. W. Mikitka
K. Mokhtarian
T. P. Pastor
M. D. Rana
G. B. Rawls, Jr.
S. C. Roberts
C. D. Rodery
A. Selz
S. C. Shah
J. C. Sowinski
C. H. Sturgeon
D. A. Swanson
K. K. Tam
E. L. Thomas, Jr.
J. Vattappilly
R. A. Whipple
K. Oyamada, *Delegate*
M. Papponetti, *Delegate*

Subgroup on Fabrication and Inspection (SC VIII)

C. D. Rodery, *Chair*
J. L. Arnold
L. F. Campbell
H. E. Gordon
W. S. Jacobs
D. J. Kreft
D. C. Lamb
J. S. Lee
B. R. Morelock
M. J. Pischke
M. J. Rice
B. F. Shelley
J. P. Swezy, Jr.
K. Oyamada, *Delegate*

Subgroup on General Requirements (SC VIII)

S. C. Roberts, *Chair*
D. B. Demichael, *Secretary*
R. J. Basile
D. T. Davis
J. P. Glaspie
K. T. Lau
M. D. Lower
C. C. Neely
A. S. Olivares
F. L. Richter
D. B. Stewart
D. A. Swanson
K. K. Tam
K. Oyamada, *Delegate*

Subgroup on Heat Transfer Equipment (SC VIII)

R. Mahadeen, *Chair*
G. Aurioles, *Secretary*
S. R. Babka
J. H. Barbee
O. A. Barsky
I. G. Campbell
M. D. Clark
J. I. Gordon
M. J. Holtz
F. E. Jehrio
D. L. Kurle
B. J. Lerch
S. Mayeux
U. R. Miller
T. W. Norton
F. Osweiller
R. J. Stastny
S. Yokell
S. M. Caldwell, *Honorary Member*
K. Oyamada, *Delegate*

Subgroup on High-Pressure Vessels (SC VIII)

J. R. Sims, Jr., *Chair*
S. Vasquez, *Secretary*
L. P. Antalffy
R. C. Biel
D. J. Burns
P. N. Chaku
R. D. Dixon
D. M. Fryer
A. H. Honza
M. M. James
P. Jansson
J. A. Kapp
J. Keltjens
D. P. Kendall
A. K. Khare
M. D. Mann
S. C. Mordre
G. J. Mraz
H. N. Patel
E. H. Perez
D. T. Peters
E. D. Roll
F. W. Tatar
S. Terada
R. Wink
K. Oyamada, *Delegate*

Subgroup on Materials (SC VIII)

J. Cameron, *Chair*
E. E. Morgenegg, *Secretary*
D. C. Agarwal
J. F. Grubb
M. Katcher
W. M. Lundy
E. G. Nisbett
D. W. Rahoi
R. C. Sutherlin
E. Upitis
K. Oyamada, *Delegate*

Special Working Group on Graphite Pressure Equipment (SC VIII)

S. Malone, *Chair*
U. D'Urso, *Staff Secretary*
F. L. Brown
B. Lukasch
M. R. Minick
E. Soltow
A. A. Stupica

Special Working Group on High-Pressure Vessels (SC VIII)

S. Vasquez, *Staff Secretary*

Task Group on Impulsively Loaded Vessels (SC VIII)

R. E. Nickell, *Chair*
G. A. Antaki
D. D. Barker
R. C. Biel
D. W. Bowman
D. L. Caldwell
A. M. Clayton
J. E. Didlake, Jr.
T. A. Duffey
R. Forgan
B. L. Haroldsen
H. L. Heaton
E. A. Rodriguez
J. R. Sims, Jr.

SUBCOMMITTEE ON WELDING (SC IX)

J. G. Feldstein, *Chair*
W. J. Sperko, *Vice Chair*
J. D. Wendler, *Staff Secretary*
D. A. Bowers
R. K. Brown, Jr.
M. L. Carpenter
L. P. Connor
P. D. Flenner
R. M. Jessee
J. S. Lee
W. M. Lundy
B. R. Newmark
A. S. Olivares
M. J. Pischke
S. D. Reynolds, Jr.
M. J. Rice
M. B. Sims
G. W. Spohn III
M. J. Stanko
P. L. Van Fosson
R. R. Young

Subgroup on Brazing (SC IX)

M. J. Pischke, *Chair*
E. W. Beckman
L. F. Campbell
M. L. Carpenter
A. F. Garbolevsky
C. F. Jeerings
J. P. Swezy, Jr.

Subgroup on General Requirements (SC IX)

B. R. Newmark, *Chair*
E. W. Beckman
P. R. Evans
R. M. Jessee
A. S. Olivares
H. B. Porter
P. L. Sturgill
K. R. Willens
E. Molina, *Delegate*

Subgroup on Materials (SC IX)

M. L. Carpenter, *Chair*
J. L. Arnold
M. Bernasek
L. P. Connor
R. M. Jessee
C. C. Kim
T. Melfi
S. D. Reynolds, Jr.
C. E. Sainz
W. J. Sperko
M. J. Stanko
R. R. Young
V. Giunto, *Delegate*

Subgroup on Performance Qualification (SC IX)

D. A. Bowers, *Chair*
V. A. Bell
L. P. Connor
R. B. Corbit
P. R. Evans
P. D. Flenner
K. L. Hayes
J. S. Lee
W. M. Lundy
M. B. Sims
G. W. Spohn III

Subgroup on Procedure Qualification (SC IX)

D. A. Bowers, *Chair*
M. J. Rice, *Secretary*
M. Bernasek
R. K. Brown, Jr.
A. S. Olivares
S. D. Reynolds, Jr.
M. B. Sims
W. J. Sperko
S. A. Sprague
J. P. Swezy, Jr.
P. L. Van Fosson
T. C. Wiesner
E. Molina, *Delegate*

SUBCOMMITTEE ON FIBER-REINFORCED PLASTIC PRESSURE VESSELS (SC X)

D. Eisberg, *Chair*
P. J. Conlisk, *Vice Chair*
S. Vasquez, *Staff Secretary*
F. L. Brown
J. L. Bustillos
T. W. Cowley
T. J. Fowler
D. H. Hodgkinson
L. E. Hunt
D. L. Keeler
B. M. Linnemann
D. J. Painter
D. J. Pinell
G. Ramirez
J. A. Rolston
B. F. Shelley
F. W. Van Name
D. O. Yancey, Jr.
P. H. Ziehl

SUBCOMMITTEE ON NUCLEAR INSERVICE INSPECTION (SC XI)

G. C. Park, *Chair*
R. W. Swayne, *Vice Chair*
R. L. Crane, *Staff Secretary*
W. H. Bamford, Jr.
R. C. Cipolla
D. D. Davis
R. L. Dyle
E. L. Farrow
R. E. Gimple
F. E. Gregor
K. Hasegawa
D. O. Henry
R. D. Kerr
S. D. Kulat
G. L. Lagleder
D. W. Lamond
J. T. Lindberg
B. R. Newton
W. E. Norris
K. Rhyne
W. R. Rogers III
D. A. Scarth
F. J. Schaaf, Jr.
J. C. Spanner, Jr.
J. E. Staffiera
G. L. Stevens
E. W. Throckmorton III
D. E. Waskey
R. A. West
C. J. Wirtz
C. S. Withers
R. A. Yonekawa
K. K. Yoon
T. Yuhara
Y.-S. Chang, *Delegate*

Executive Committee (SC XI)

R. W. Swayne, *Chair*
G. C. Park, *Vice Chair*
R. L. Crane, *Staff Secretary*
W. H. Bamford, Jr.
D. D. Davis
R. L. Dyle
R. E. Gimple
F. E. Gregor
O. F. Hedden
C. G. McCargar
W. E. Norris
K. Rhyne
F. J. Schaaf, Jr.
J. C. Spanner, Jr.
E. W. Throckmorton III
R. A. West
R. A. Yonekawa

Honorary Members (SC XI)

L. J. Chockie
C. D. Cowfer
O. F. Hedden
J. P. Houstrup
L. R. Katz
P. C. Riccardella

Subgroup on Evaluation Standards (SG-ES) (SC XI)

W. H. Bamford, Jr., *Chair*
G. L. Stevens, *Secretary*
H.-D. Chung
R. C. Cipolla
G. H. De Boo
B. R. Ganta
T. J. Griesbach
K. Hasegawa
D. N. Hopkins
Y. Imamura
K. Koyama
D. R. Lee
H. S. Mehta
J. G. Merkle
K. Miyazaki
S. Ranganath
D. A. Scarth
T.-L. Sham
K. R. Wichman
K. K. Yoon
Y.-S. Chang, *Delegate*

Working Group on Flaw Evaluation (SG-ES) (SC XI)

R. C. Cipolla, *Chair*
G. H. De Boo, *Secretary*
W. H. Bamford, Jr.
M. Basol
J. M. Bloom
H.-D. Chung
B. R. Ganta
T. J. Griesbach
H. L. Gustin
F. D. Hayes
A. L. Hiser, Jr.
P. H. Hoang
D. N. Hopkins
K. Koyama
D. R. Lee
H. S. Mehta
J. G. Merkle
K. Miyazaki
R. K. Qashu
S. Ranganath
P. J. Rush
D. A. Scarth
T. S. Schurman
W. L. Server
K. R. Wichman
G. M. Wilkowski
K. K. Yoon
V. A. Zilberstein

Working Group on Operating Plant Criteria (SG-ES) (SC XI)

T. J. Griesbach, *Chair*
K. R. Baker
W. H. Bamford, Jr.
H. Behnke
B. A. Bishop
T. L. Dickson
S. R. Gosselin
M. Hayashi
S. N. Malik
H. S. Mehta
R. Pace
S. Ranganath
W. L. Server
E. A. Siegel
G. L. Stevens
D. P. Weakland
K. K. Yoon

Working Group on Pipe Flaw Evaluation (SG-ES) (SC XI)

D. A. Scarth, *Chair*
G. M. Wilkowski, *Secretary*
T. A. Bacon
W. H. Bamford, Jr.
H.-D. Chung
R. C. Cipolla
N. G. Cofie
J. M. Davis
G. H. De Boo
B. R. Ganta
L. F. Goyette
K. Hasegawa
A. L. Hiser, Jr.
P. H. Hoang
D. N. Hopkins
K. Kashima
R. O. McGill
H. S. Mehta
K. Miyazaki
P. J. Rush
T.-L. Sham
K. K. Yoon
V. A. Zilberstein

Subgroup on Nondestructive Examination (SG-NDE) (SC XI)

J. C. Spanner, Jr., *Chair*
G. A. Lofthus, *Secretary*
T. L. Chan
C. B. Cheezem
D. R. Cordes
F. J. Dodd
F. E. Dohmen
M. E. Gothard
D. O. Henry
M. R. Hum
G. L. Lagleder
J. T. Lindberg
G. R. Perkins
A. S. Reed
F. J. Schaaf, Jr.
C. J. Wirtz

Working Group on Personnel Qualification and Surface, Visual, and Eddy Current Examination (SG-NDE) (SC XI)

A. S. Reed, *Chair*
D. R. Cordes, *Secretary*
B. L. Curtis
N. Farenbaugh
D. O. Henry
J. W. Houf
J. T. Lindberg
T. R. Lupold
D. R. Quattlebaum, Jr.
D. Spake
J. C. Spanner, Jr.
M. C. Weatherly
C. J. Wirtz

Working Group on Pressure Testing (SG-WCS) (SC XI)

D. W. Lamond, *Chair*
J. M. Boughman, *Secretary*
J. J. Churchwell
G. L. Fechter
K. W. Hall
R. E. Hall
A. McNeill III
B. L. Montgomery
E. J. Sullivan, Jr.

Working Group on Procedure Qualification and Volumetric Examination (SG-NDE) (SC XI)

M. E. Gothard, *Chair*
G. R. Perkins, *Secretary*
M. T. Anderson
C. B. Cheezem
A. D. Chockie
S. R. Doctor
F. J. Dodd
F. E. Dohmen
K. J. Hacker
R. A. Kellerhall
D. Kurek
G. L. Lagleder
G. A. Lofthus
C. E. Moyer
S. A. Sabo
R. V. Swain

Subgroup on Repair/Replacement Activities (SG-RRA) (SC XI)

R. A. Yonekawa, *Chair*
E. V. Farrell, Jr., *Secretary*
S. B. Brown
R. E. Cantrell
P. D. Fisher
E. B. Gerlach
R. E. Gimple
D. R. Graham
R. A. Hermann
K. J. Karwoski
R. D. Kerr
S. L. McCracken
B. R. Newton
J. E. O'Sullivan
W. R. Rogers III
R. R. Stevenson
R. W. Swayne
D. E. Waskey
J. G. Weicks
C. S. Withers

Working Group on Design and Programs (SG-RRA) (SC XI)

E. B. Gerlach, *Chair*
S. B. Brown, *Secretary*
O. Bhatty
R. R. Croft
G. G. Elder
E. V. Farrell, Jr.
S. K. Fisher
J. M. Gamber
D. R. Graham
G. F. Harttraft
M. A. Pyne
R. R. Stevenson
R. W. Swayne
A. H. Taufique
T. P. Vassallo, Jr.
R. A. Yonekawa

Working Group on Welding and Special Repair Process (SG-RRA) (SC XI)

D. E. Waskey, *Chair*
R. E. Cantrell, *Secretary*
S. J. Findlan
P. D. Fisher
M. L. Hall
R. A. Hermann
K. J. Karwoski
C. C. Kim
M. Lau
S. L. McCracken
B. R. Newton
J. E. O'Sullivan
R. E. Smith
D. J. Tilly
J. G. Weicks
K. R. Willens

Subgroup on Water-Cooled Systems (SG-WCS) (SC XI)

E. W. Throckmorton III, *Chair*
J. M. Agold, *Secretary*
J. M. Boughman
M. L. Coats
D. D. Davis
H. Q. Do
E. L. Farrow
M. J. Ferlisi
O. F. Hedden
M. L. Herrera
S. D. Kulat
D. W. Lamond
A. McNeill III
W. E. Norris
D. Song
J. E. Staffiera
H. M. Stephens, Jr.
K. B. Thomas
R. A. West
G. E. Whitman
H. L. Graves III, *Alternate*

Working Group on Containment (SG-WCS) (SC XI)

J. E. Staffiera, *Chair*
H. G. Ashar
S. G. Brown
K. K. N. Chao
R. C. Cox
J. W. Crider
M. J. Ferlisi
D. H. Goche
H. L. Graves III
H. T. Hill
R. D. Hough
C. N. Krishnaswamy
D. J. Naus
H. M. Stephens, Jr.
W. E. Norris, *Alternate*

Working Group on ISI Optimization (SG-WCS) (SC XI)

E. A. Siegel, *Chair*
D. R. Cordes, *Secretary*
W. H. Bamford, Jr.
J. M. Boughman
M. E. Gothard
R. E. Hall
A. H. Mahindrakar
D. G. Naujock
S. R. Scott
K. B. Thomas
G. E. Whitman
Y. Yuguchi

Working Group on Implementation of Risk-Based Examination (SG-WCS) (SC XI)

S. D. Kulat, *Chair*
A. McNeill III, *Secretary*
J. M. Agold
B. A. Bishop
S. T. Chesworth
C. Cueto-Felgueroso
H. Q. Do
R. Fougerousse
M. R. Graybeal
J. Hakii
K. W. Hall
A. T. Keim
D. W. Lamond
J. T. Lindberg
R. K. Mattu
P. J. O'Regan
N. A. Palm
M. A. Pyne
R. A. West
J. C. Younger

Working Group on Inspection of Systems and Components (SG-WCS) (SC XI)

K. B. Thomas, *Chair*
D. Song, *Secretary*
J. M. Agold
V. L. Armentrout
C. Cueto-Felgueroso
H. Q. Do
R. Fougerousse
M. R. Hum
S. D. Kulat
T. A. Meyer
D. G. Naujock
T. Nomura
C. M. Ross
R. A. West
G. E. Whitman

Working Group on General Requirements (SC XI)

K. Rhyne, *Chair*
E. J. Maloney, *Secretary*
G. P. Alexander
T. L. Chan
M. L. Coats
E. L. Farrow
R. K. Mattu
S. R. Scott
G. E. Szabatura
C. S. Withers

Special Working Group on Editing and Review (SC XI)

R. W. Swayne, *Chair*
C. E. Moyer
K. R. Rao
J. E. Staffiera
D. J. Tilly
C. J. Wirtz

Special Working Group on Plant Life Extension (SC XI)

T. A. Meyer, *Chair*
D. V. Burgess, *Secretary*
S. Asada
D. D. Davis
F. E. Gregor
P.-T. Kuo
R. E. Nickell
W. L. Server
R. L. Turner
G. G. Young

Special Working Group on High-Temperature, Gas-Cooled Reactors (SC XI)

J. Fletcher, *Chair*
M. A. Lockwood, *Secretary*
N. Broom
C. Cueto-Felgueroso
K. N. Fleming
S. R. Gosselin
M. R. Graybeal
A. B. Hull
W. A. O. Kriel
M. N. Mitchell
F. J. Schaaf, Jr.
F. Shahrokhi
R. W. Swayne

SUBCOMMITTEE ON TRANSPORT TANKS (SC XII)

A. Selz, *Chair*
D. R. Sharp, *Staff Secretary*
D. M. Allbritten
A. N. Antoniou
C. Becht IV
M. A. Garrett
C. H. Hochman
G. G. Karcher
G. McRae
M. D. Pham
M. D. Rana
T. A. Rogers
W. K. Smith
S. Staniszewski
M. R. Toth
A. P. Varghese
M. R. Ward
L. Wolpert

Subgroup on Design and Materials (SC XII)

M. D. Rana, *Chair*
D. R. Sharp, *Staff Secretary*
G. G. Karcher
S. L. McWilliams
N. J. Paulick
M. D. Pham
T. A. Rogers
A. P. Varghese
M. R. Ward
E. A. Whittle

Subgroup on Fabrication and Inspection (SC XII)

G. McRae, *Chair*
D. R. Sharp, *Staff Secretary*
J. A. Byers
B. L. Gehl
L. D. Holsinger
D. J. Kreft
A. S. Olivares
L. H. Strouse

Subgroup on General Requirements (SC XII)

C. H. Hochman, *Chair*
D. R. Sharp, *Staff Secretary*
T. W. Alexander
D. M. Allbritten
C. A. Betts
J. F. Cannon
J. L. Freiler
W. L. Garfield
M. A. Garrett
K. L. Gilmore
J. L. Rademacher
T. Rummel
W. K. Smith
L. H. Strouse
M. R. Toth
L. Wolpert

Subgroup on Nonmandatory Appendices (SC XII)

T. A. Rogers, *Chair*
D. R. Sharp, *Staff Secretary*
D. D. Brusewitz
J. L. Conley
T. Eubanks
B. L. Gehl
T. Hitchcock
S. L. McWilliams
J. L. Rademacher
A. Selz
S. Staniszewski
A. P. Varghese
M. R. Ward
L. Wolpert

SUBCOMMITTEE ON BOILER AND PRESSURE VESSEL ACCREDITATION (SC-BPVA)

W. C. LaRochelle, *Chair*
P. D. Edwards, *Vice Chair*
K. I. Baron, *Secretary*
W. J. Bees
M. B. Doherty
D. J. Jenkins
K. T. Lau
L. E. McDonald
K. M. McTague
D. Miller
B. R. Morelock
J. D. O'Leary
D. E. Tanner
B. C. Turczynski
D. E. Tuttle
E. A. Whittle
G. Bynog, *Alternate*
D. C. Cook, *Alternate*
M. A. DeVries, *Alternate*
C. E. Ford, *Alternate*
T. E. Hansen, *Alternate*
G. L. Hollinger, *Alternate*
B. B. MacDonald, *Alternate*
R. D. Mile, *Alternate*
G. P. Milley, *Alternate*
M. R. Minick, *Alternate*
T. W. Norton, *Alternate*
H. R. Staehr, *Alternate*
J. A. West, *Alternate*
R. V. Wielgoszinski, *Alternate*
A. J. Spencer, *Honorary Member*
O. E. Trapp, *Contributing Member*

SUBCOMMITTEE ON NUCLEAR ACCREDITATION (SC-NA)

R. R. Stevenson, *Chair*
W. C. LaRochelle, *Vice Chair*
J. Pang, *Staff Secretary*
M. N. Bressler
S. M. Goodwin
K. A. Huber
M. Kotb
J. C. Krane
C. A. Lizotte
R. P. McIntyre
M. R. Minick
H. B. Prasse
T. E. Quaka
D. E. Tanner
D. M. Vickery
G. Bynog, *Alternate*
G. Deily, *Alternate*
P. D. Edwards, *Alternate*
D. P. Gobbi, *Alternate*
J. W. Highlands, *Alternate*
K. M. Hottle, *Alternate*
B. G. Kovarik, *Alternate*
P. F. Prescott, *Alternate*
S. M. Scott, *Alternate*
D. W. Stepp, *Alternate*
E. A. Whittle, *Alternate*
R. V. Wielgoszinski, *Alternate*
H. L. Wiger, *Alternate*
O. E. Trapp, *Contributing Member*

SUBCOMMITTEE ON DESIGN (SC-D)

R. J. Basile, *Chair*
R. W. Barnes
M. R. Breach
R. P. Deubler
G. G. Graven
G. L. Hollinger
R. I. Jetter
D. P. Jones
R. W. Mikitka
U. R. Miller
W. J. O'Donnell
R. D. Schueler, Jr.

Subgroup on Design Analysis (SC-D)

G. L. Hollinger, *Chair*
M. R. Breach
R. G. Brown
R. J. Gurdal
C. F. Heberling II
C. E. Hinnant
P. Hirschberg
D. P. Jones
A. Kalnins
W. J. Koves
K. Matsunaga
G. A. Miller
W. D. Reinhardt
D. H. Roarty
G. Sannazzaro
T. G. Seipp
D. A. Swanson
G. Taxacher
E. L. Thomas, Jr.
R. A. Whipple

Subgroup on Elevated Temperature Design (SC-D)

R. I. Jetter, *Chair*
T. Asayama
C. Becht IV
J. F. Cervenka
D. S. Griffin
B. F. Hantz
M. H. Jawad
W. J. Koves
S. Majumdar
D. L. Marriott
T. E. McGreevy
W. J. O'Donnell
D. A. Osage
J. S. Porowski
B. Riou
T.-L. Sham
M. S. Shelton
R. W. Swindeman

Subgroup on Fatigue Strength (SC-D)

W. J. O'Donnell, *Chair*
P. R. Donavin
R. J. Gurdal
C. F. Heberling II
P. Hirschberg
P. Hsu
D. P. Jones
G. Kharshafdjian
S. Majumdar
T. Nakamura
D. H. Roarty
G. Taxacher
H. H. Ziada

Subgroup on Openings (SC-D)

M. R. Breach, *Chair*
R. W. Mikitka, *Secretary*
G. G. Graven
V. T. Hwang
J. C. Light
R. B. Luney
J. P. Madden
D. R. Palmer
J. A. Pfeifer
M. D. Rana
E. C. Rodabaugh
C. R. Thomas

Special Working Group on Bolted Flanged Joints (SC-D)

R. W. Mikitka, *Chair*
G. D. Bibel
H. A. Bouzid
W. Brown
A. Chaudouet
W. J. Koves
E. Michalopoulos
J. R. Payne
P. G. Scheckermann
R. D. Schueler, Jr.
A. Selz
M. S. Shelton

SUBCOMMITTEE ON SAFETY VALVE REQUIREMENTS (SC-SVR)

S. F. Harrison, Jr., *Chair*
J. A. West, *Vice Chair*
S. J. Rossi, *Staff Secretary*
J. F. Ball
S. Cammeresi
A. Cox
R. D. Danzy
D. B. Demichael
R. J. Doelling
J. P. Glaspie
H. I. Gregg
W. F. Hart
D. Miller
T. M. Parks
D. K. Parrish
D. J. Scallan
Z. Wang

Subgroup on Design (SC-SVR)

J. A. West, *Chair*
C. E. Beair
R. D. Danzy
R. J. Doelling
H. I. Gregg
D. Miller
T. Patel
T. R. Tarbay

Subgroup on General Requirements (SC-SVR)

D. B. Demichael, *Chair*
J. F. Ball
G. Brazier
J. P. Glaspie
D. K. Parrish
J. W. Ramsey
J. W. Richardson
D. E. Tuttle

Subgroup on Testing (SC-SVR)

A. Cox, *Chair*
J. E. Britt
S. Cammeresi
G. D. Goodson
W. F. Hart
B. K. Nutter
D. J. Scallan
Z. Wang

U.S. Technical Advisory Group ISO/TC 185 Safety Relief Valves

T. J. Bevilacqua, *Chair*
S. J. Rossi, *Staff Secretary*
J. F. Ball
D. B. Demichael
Y.-S. Lai
D. Miller
J. A. West

INTENTIONALLY LEFT BLANK

PERSONNEL
Officers of ASTM Committee

(Cooperating in the Development of the Specifications Herein)
As of January 1, 2008

D-20 ON PLASTICS

D. M. Oates, *Chair*
S. Bailey, *Editor*
F. A. Boldt, *Materials Vice Chair*
G. R. Cornell, *Programs Vice Chair*
J. Galipeau, *Methods Vice Chair*
A. D. Kupfer, *Products Vice Chair*
M. L. Lavach, *Membership Vice Chair*
E. Olcese, *Editor*
S. E. Osborn, *Secretary*
K. Paul, *Administrative Assistant*
H. E. Yohn, *Liaison-Research Vice Chair*

INTENTIONALLY LEFT BLANK

HW-702. For seamless heads, use $E = 1$, except for hemispherical heads furnished without a skirt, in which case use the efficiency of the head-to-shell joint.

L = inside spherical or crown radius

P = design pressure [but not less than 30 psi (200 kPa)]

S = maximum allowable stress value as given in Tables HF-300.1 and HF-300.2

t = required wall thickness after forming

HG-305.2 Ellipsoidal Heads. The required thickness and the design pressure of a dished head of semiellipsoidal form, in which half the minor axis (inside depth of the head minus the skirt) equals one-fourth of the inside diameter of the head skirt, shall be calculated by the following formulas:

$$t = \frac{PD}{2SE - 0.2P}$$

or

$$P = \frac{2SEt}{D + 0.2t}$$

HG-305.3 Torispherical Heads. The required thickness and the design pressure of a torispherical head shall be calculated by the following formulas (see HG-305.6):

$$t = \frac{0.885PL}{SE - 0.1P}$$

or

$$P = \frac{SEt}{0.885L + 0.1t}$$

HG-305.4 Hemispherical Heads. The required thickness and the design pressure of a hemispherical head in which P does not exceed $0.665SE$ shall be calculated by the following formulas:

$$t = \frac{PL}{2SE - 0.2P}$$

or

$$P = \frac{2SEt}{L + 0.2t}$$

HG-305.5 Formed Heads With Stays. A formed head of a lesser thickness than that required by the rules of this paragraph may be used provided it is stayed as a flat surface according to the rules of HG-340 for stayed flat plates, no allowance being made in such staying for the holding power due to the curvature of the head unless all the following conditions are met:

(a) the head is at least two-thirds as thick as required by the rules of this paragraph for an unstayed head

(b) the head is at least $\frac{7}{8}$ in. (22 mm) thick

(c) the stays are through-stays attached to the head by outside and inside nuts

(d) the design pressure on the head is taken as that calculated for an unstayed formed head plus the pressure calculated for the stays by the formula for stayed surfaces in HG-340 using a value of $C = 1.63$

HG-305.6 Inside Crown Radius of Unstayed Heads. The inside crown radius to which an unstayed formed head is dished shall be not greater than the outside diameter of the skirt of the head. The inside knuckle radius of a torispherical head shall be not less than 6% of the outside diameter of the skirt of the head but in no case less than three times the head thickness.

HG-305.7 Heads Built Up of Several Shapes. A head for a cylindrical shell may be built up of several head shapes, the thicknesses of which satisfy the requirements of the appropriate formulas above, provided that adjoining shapes are so formed that they have a common tangent transverse to the joint.

HG-305.8 Length of Skirts. The required length of skirt on heads concave and convex to pressure shall comply with HW-715.

HG-305.9 Permissible Diameter of Flat Spots on Formed Heads. If a torispherical, ellipsoidal, or hemispherical head is formed with a flattened spot or surface, the diameter of the flat spot shall not exceed that permitted for flat heads as given by the formula in HG-307, using $C = 0.20$.

HG-306 FORMED HEADS, PRESSURE ON CONVEX SIDE

HG-306.1 Unstayed dished heads with the pressure on the convex side shall have a design pressure equal to 60% of that for heads of the same dimensions having the pressure on the concave side (see HG-305).

HG-307 FLAT HEADS

HG-307.1 General. The minimum thickness of unstayed heads, cover plates, and blind flanges shall conform to the requirements given in this paragraph. These requirements apply to both circular and noncircular heads and covers. In addition, flat heads or covers made of cast iron shall be subjected to the proof test provisions of HG-500. Some acceptable types of flat heads and covers are shown in Fig. HG-307.

(a) The symbols used in this paragraph and Fig. HG-307 are defined as follows: A08

C = a factor depending upon the method of attachment of the head, shell, pipe, or header dimensions, and other items as listed in HG-307.4 below, dimensionless. The factors for welded covers also include a factor of 0.667 that effectively increases the allowable stress for such construction to $1.5S$.

D = long span of noncircular heads or covers measured perpendicular to short span

d = diameter, or short span, measured as indicated in Fig. HG-307

H_G = gasket moment arm, equal to the radial distance from the center line of the bolts to the line of the gasket reaction, as shown in Fig. HG-307, sketches (j) and (k)

L = perimeter of noncircular bolted head measured along the centers of the bolt holes

l = length of flange or flanged heads, measured from the tangent line of knuckle, as indicated in Fig. HG-307, sketches (a) and (c)

m = the ratio t_r/t_s, dimensionless

P = design pressure

r = inside corner radius on the head formed by flanging or forging

S = maximum allowable stress value using values given in Tables HF-300.1 and HF-300.2

t = minimum required thickness of flat head or cover

t_e = minimum distance from beveled end of drum, pipe, or header, before welding, to outer face of head, as indicated in Fig. HG-307, sketch (i),

t_f = actual thickness of the flange on a forged head, at the large end, as indicated in Fig. HG-307, sketch (b)

t_h = actual thickness of flat head or cover

t_r = required thickness of seamless shell, pipe, or header, for pressure

t_s = actual thickness of shell, pipe, or header

t_w = thickness through the weld joining the edge of a head to the inside of a drum, pipe, or header, as indicated in Fig. HG-307, sketch (g)

t_1 = throat dimension of the closure weld, as indicated in Fig. HG-307, sketch (r)

W = total bolt load as further defined in HG-307.2

Z = a factor for noncircular heads and covers that depends on the ratio of short span to long span, as given in HG-307.3 below, dimensionless

HG-307.2 Thickness of Circular, Flat, Unstayed Heads, Covers, and Blind Flanges. The thickness of flat unstayed heads, covers, and blind flanges shall conform to one of the following requirements:[2]

(a) Circular blind flanges of ferrous materials conforming to ANSI B16.5 shall be acceptable for the diameters and pressure–temperature ratings in Tables 2 to 8 of that Standard when of the types shown in Fig. HG-307, sketches (j) and (k).

(b) The minimum required thickness of flat unstayed circular heads, covers, and blind flanges shall be calculated by the following formula:

$$t = d\sqrt{CP/S} \qquad (1)$$

except when the head, cover, or blind flange is attached by bolts causing an edge moment [Fig. HG-307, sketches (j) and (k)], in which case the thickness shall be calculated by

$$t = d\sqrt{CP/S + 1.9WH_G/Sd^3} \qquad (2)$$

When using Formula (2), the thickness t shall be calculated for both operating conditions and gasket seating, and the greater of the two values shall be used. For operating conditions, the value of P shall be the design pressure, the value of S at design temperature shall be used, and W shall be the sum of the bolt loads required to resist the end pressure load and to maintain tightness of the gasket. For gasket seating, P equals zero, the value of S at atmospheric temperature shall be used, and W shall be the average of the required bolt load and the load available from the bolt area actually used.

HG-307.3 Thickness of Noncircular, Flat, Unstayed Heads, Covers, and Blind Flanges

(a) Flat unstayed heads, covers, or blind flanges may be square, rectangular, elliptical, obround, segmental, or otherwise noncircular. Their required thickness shall be calculated by the following formula:

$$t = d\sqrt{ZCP/S} \qquad (3)$$

where

$$Z = 3.4 - \frac{2.4d}{D} \qquad (4)$$

with the limitation that Z need not be greater than 2.5.

(b) Formula (3) does not apply to noncircular heads, covers, or blind flanges attached by bolts causing a bolt edge moment [Fig. HG-307, sketches (j) and (k)]. For noncircular heads of this type, the required thickness shall be calculated by the following formula:

$$t = d\sqrt{ZCP/S + 6WH_G/SLd^2} \qquad (5)$$

When using Formula (5), the thickness t shall be calculated in the same way as specified above for Formula (2).

HG-307.4 Values of C for Use in Formulas in HG-307.2 and HG-307.3. For the types of construction shown in Fig. HG-307, the values of C to be used in Formulas (1), (2), (3), and (5) are as follows:

(a) Figure HG-307, sketch (a): $C = 0.17$ for flanged circular and noncircular heads forged integral with or butt welded to the shell, pipe, or header, with an inside corner radius not less than three times the required head thickness,

---

[2] The formulas provide safe construction as far as stress is concerned. Greater thicknesses may be necessary if deflection would cause leakage at threaded or gasketed joints.

the valve seat is above the bottom of the inside diameter of the discharge piping. For valves exceeding NPS 2½ (DN 65) the drain hole or holes shall be tapped not less than NPS ⅜ (DN 10). For valves NPS 2½ (DN 65) or smaller, the drain hole shall not be less than ¼ in. (6 mm) in diameter. Body drain connections shall not be plugged during or after field installation. In safety relief valves of the diaphragm type, the space above the diaphragm shall be vented to prevent a buildup of pressure above the diaphragm. Safety relief valves of the diaphragm type shall be so designed that failure or deterioration of the diaphragm material will not impair the ability of the valve to relieve at the rated capacity.

(i) In the design of the body of the valve consideration shall be given to minimizing the effects of water deposits.

(j) Valves shall be provided with wrenching surfaces to allow for normal installation without damaging operating parts.

(k) The set pressure tolerances, plus or minus, of safety valves shall not exceed 2 psi (15 kPa), and for safety relief valves shall not exceed 3 psi (20 kPa) for pressures up to and including 60 psig (400 kPa) and 5% for pressures above 60 psig (400 kPa).

(l) Safety valves shall be arranged so that they cannot be reset to relieve at a higher pressure than the maximum allowable working pressure of the boiler.

HG-401.2 Material Selection

(a) Cast iron seats and disks are not permitted.

(b) Adjacent sliding surfaces such as guides and disks shall both be of corrosion resistant material.

(c) Springs of corrosion resistant material or having a corrosion resistant coating are required.

(d) Material for seats and disks should be such as to provide a reasonable degree of resistance to steam cutting.

(e) Material for valve bodies and bonnets or their corresponding metallic pressure containing parts shall be listed in Section II, except that in cases where a manufacturer desires to make use of materials other than those listed in Section II, he shall establish and maintain specifications requiring equivalent control of chemical and physical properties and quality.

(f) Synthetic disk inserts of O-ring or other types if used shall be compatible with the maximum design temperature established for the valve.

(g) No materials liable to fail due to deterioration or vulcanization when subjected to saturated steam temperature corresponding to capacity test pressure shall be used.

HG-401.3 Manufacture and Inspection

(a) A Manufacturer shall demonstrate to the satisfaction of an ASME designee that his manufacturing, production, and testing facilities and quality control procedures will insure close agreement between the performance of random production samples and the performance of those valves submitted for capacity certification.

(b) Manufacturing, inspection, and test operations including capacity are subject to inspections at any time by an ASME designee.

(c) A Manufacturer may be granted permission to apply the HV Code Symbol to production pressure relief valves capacity certified in accordance with HG-402.3 provided the following tests are successfully completed. This permission shall expire on the fifth anniversary of the date it is initially granted. The permission may be extended for 5 year periods if the following tests are successfully repeated within the 6 month period before expiration.

(1) Two sample production pressure relief valves of a size and capacity within the capability of an ASME accepted laboratory shall be selected by an ASME designee.

(2) Operational and capacity tests shall be conducted in the presense of an ASME designee at an ASME accepted laboratory. The valve Manufacturer shall be notified of the time of the test and may have representatives present to witness the test.

(3) Should any valve fail to relieve at or above its certified capacity or should it fail to meet performance requirements of this Section, the test shall be repeated at the rate of two replacement valves, selected in accordance with HG-401.3(c)(1), for each valve that failed.

(4) Failure of any of the replacement valves to meet the capacity or the performance requirements of this Section shall be cause for revocation within 60 days of the authorization to use the Code Symbol on that particular type of valve. During this period, the Manufacturer shall demonstrate the cause of such deficiency and the action taken to guard against future occurrence, and the requirements of HG-401.3(c) above shall apply.

(d) Safety valves shall be sealed in a manner to prevent the valve from being taken apart without breaking the seal. Safety relief valves shall be set and sealed so that they cannot be reset without breaking the seal.

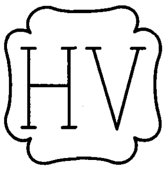
HG-401.4 Manufacturer's Testing

(a) Every safety valve shall be tested to demonstrate its popping point, blowdown, and tightness. Every safety relief valve shall be tested to demonstrate its opening point and tightness. Safety valves shall be tested on steam or air and safety relief valves on water, steam, or air. When the blowdown is nonadjustable, the blowdown test may be performed on a sampling basis.

(b) A Manufacturer shall have a well-established program for the application, calibration, and maintenance of test gages.

(c) Testing time on safety valves shall be sufficient, depending on size and design, to insure that test results are repeatable and representative of field performance.

FIG. HG-402 OFFICIAL SYMBOL FOR STAMP TO DENOTE THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS' STANDARD



(d) Test fixtures and test drums shall be of adequate size and capacity to assure representative pop action and accuracy of blowdown adjustment.

(e) A tightness test shall be conducted at maximum expected operating pressure, but not at a pressure exceeding the reseating pressure of the valve.

HG-401.5 Design Requirements. At the time of the submission of valves for capacity certification, or testing in accordance with this Section, the ASME Designee has the authority to review the design for conformity with the requirements of this Section, and to reject or require modification of designs that do not conform, prior to capacity testing.

HG-402 DISCHARGE CAPACITIES OF SAFETY AND SAFETY RELIEF VALVES

A08 **HG-402.1 Valve Markings.** Each safety or safety-relief valve shall be plainly marked with the required data by the Manufacturer in such a way that the markings will not be obliterated in service. The markings shall be stamped, etched, impressed, or cast on the valve or on a nameplate, which shall be securely fastened to the valve.

For units other than those included below, see HG-102.

(a) The markings shall include the following:

(1) the name or an acceptable abbreviation of the Manufacturer

(2) Manufacturer's design or type number

(3) NPS size ______ in. (DN) (the nominal pipe size of the valve inlet)

(4) set pressure ______ psi

(5) capacity _____ lb/hr (kg/hr), or capacity ______ Btu/hr in accordance with HG-402.7(a)

(6) year built or, alternatively, a coding may be marked on the valves such that the valve Manufacturer can identify the year the valve was assembled and tested, and

(7) ASME Symbol as shown in Fig. HG-402

HG-402.2 Authorization to Use ASME Stamp. Each safety valve to which the Code Symbol (Fig. HG-402) is to be applied shall be produced by a Manufacturer and/or Assembler who is in possession of a valid Certificate of Authorization. (See HG-540.)

For all valves to be stamped with the HV Symbol, a Certified Individual (CI) shall provide oversight to ensure that the use of the "HV" Code symbol on a safety valve or safety relief valve is in accordance with this Section and that the use of the "HV" Code symbol is documented on a Certificate of Conformance Form, HV-1.

(a) Requirements for the Certified Individual (CI). The CI shall

(1) be an employee of the Manufacturer.

(2) be qualified and certified by the Manufacturer. Qualification shall include the following as a minimum:

(a) knowledge of the requirements of this Section for the application of the "HV" Code Symbol

(b) knowledge of the Manufacturer's quality program

(c) training commensurate with the scope, complexity, or special nature of the activities to which oversight is to be provided

(3) have a record, maintained and certified by the Manufacturer, containing objective evidence of the qualifications of the CI and the training program provided

(b) Duties of the Certified Individual (CI). The CI shall

(1) verify that each item to which the Code Symbol is applied meets all applicable requirements of this Section and has a current capacity certification for the "HV" symbol

(2) review documentation for each lot of items to be stamped, to verify, for the lot, that the requirements of this Section have been completed

(3) sign the Certificate of Conformance Form (HV-1) prior to release of control of the item

(c) Certificate of Conformance Form (HV-1) (see Appendix N)

(1) The Certificate of Conformance shall be filled out by the Manufacturer and signed by the Certified Individual. Multiple duplicate pressure relief devices may be recorded on a single entry provided the devices are identical and produced in the same lot.

(2) The Manufacturer's written quality control program shall include requirements for completion of Certificates of Conformance forms and retention by the Manufacturer for a minimum of 5 years.

HG-402.3 Determination of Capacity to Be Stamped on Valves. The Manufacturer of the valves that are to be

(3) checking to see that material used in the construction of the boiler and parts complies with the requirements (see HG-200, HF-200, and HB-1100)

(4) checking to see that all welding procedures have been qualified (see HW-910)

(5) checking to see that all welders and welding operators have been qualified (see HW-911)

(6) checking to see that all brazing procedures have been qualified (see HB-1501)

(7) checking to see that all brazer and brazer operators have been qualified (see HB-1502)

(8) checking to see that the proper joint factor is used for brazed joints that can only be inspected from one side (blind joint) (see HB-1503)

(9) checking to see that material imperfections repaired by welding were acceptably repaired (see HW-830 and HB-1402)

(10) visual inspection of boiler parts to confirm that the material identification numbers have been properly transferred (see HF-210)

(11) witnessing of proof tests conducted to establish the maximum allowable working pressure of boilers (see HG-500)

(12) inspecting each boiler and water heater during construction and after completion (see HG-515.3)

(13) performing internal and external inspections and witnessing hydrostatic tests (see HG-510)

(14) verifying that stamping and/or nameplate is proper and that it has been stamped and/or attached to the proper boiler (see HG-530 through HG-533)

(15) signing the certificate of inspection on the Manufacturer's Data Report when the boiler or part is complete and in compliance with all the provisions of this Section (see HG-532.3, HG-533.6, and HG-520.2)

HG-515.4 Duty of Authorized Inspector

(a) Each boiler shall be inspected during construction and after completion and, at the option of the Authorized Inspector, at such other stages of the work as he may designate. For specific requirements, see the applicable parts of this Section. Each Manufacturer or assembler is required to arrange for the services of Authorized Inspectors (see HG-515.2) to perform such inspections on all of this work within the scope of this Section, whether performed in the shop or in the field.

(b) When multiple, duplicate boiler fabrication makes it impracticable for the Inspector to personally perform each of his required duties, the Manufacturer, in collaboration with the Inspector, shall prepare an inspection and quality control procedure setting forth in complete detail the method by which the requirements of this Section shall be maintained (see HG-515 for summaries of the responsibilities of the Manufacturer and the duties of the Inspector). This procedure shall be included in the Manufacturer's written Quality Control System (see HG-540). This procedure shall be submitted to, and shall have received the acceptance of, the inspection agency. It shall then be submitted by the inspection agency for written acceptance by the legal jurisdiction concerned and by an ASME Designee. The inspection procedure shall be used in the plant of the named Manufacturer by the inspection agency submitting it, and shall be carried out by an Inspector in the employ of that inspection agency. Any changes in this inspection and Quality Control Procedure that affect the requirements of this Section are subject to review and acceptance by the parties required for a joint review. The joint reviews required by HG-540 shall include an ASME Designee. The Data Report for a multiple duplicate boiler shall include under "Remarks," the statement "Constructed under the provisions of HG-515.4(b)."

HG-520 MASTER AND PARTIAL DATA REPORTS

HG-520.1 Manufacturer's Master Data Report. Each manufacturer of heating boilers of wrought materials to which the Code H Symbol is to be applied shall compile a Manufacturer's Data Report for each boiler he produces, except that an individual Manufacturer's Data Report may be used to include the serial numbers in uninterrupted sequence of identical boilers completed, inspected, and stamped in a continuous 8 hr period. Form H-2 or H-3 shall be used.

(a) The boiler Manufacturer shall have the responsibility of furnishing a copy of the completed Manufacturer's Data Report at the place of installation to the inspection agency, the purchaser, and the state, municipal, or provincial authority.

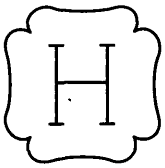
(b) The Manufacturer shall either keep a copy of the Manufacturer's Data Report on file for at least 5 years, or the boiler may be registered and the original Data Report filed with the National Board of Boiler and Pressure Vessel Inspectors, 1055 Crupper Avenue, Columbus, Ohio 43229

HG-520.2 Partial Data Reports

(a) Manufacturer's Partial Data Reports for those parts of a boiler requiring inspection under this Code, which are furnished by other than the shop of the manufacturer responsible for the completed boiler, shall be executed by the parts manufacturer and shall be forwarded in duplicate to the manufacturer of the finished boiler.

(b) Partial Data Reports (Form H-4) shall be completed for all parts that require inspection under this Code that are fabricated by a manufacturer other than the manufacturer of the completed boiler. These Partial Data Reports, together with his own inspection, shall be the final Authorized Inspector's authority to witness the application of the Code Symbol to the completed boiler.

FIG. HG-530.1 OFFICIAL SYMBOL FOR STAMP TO DENOTE THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS' STANDARD



HG-520.3 Supplementary Sheet. Form H-6, Manufacturer's Data Report Supplementary Sheet, shall be used to record additional data where space was insufficient on a Data Report Form. This Manufacturer's Data Report Supplementary Sheet will be attached to the Manufacturer's Data Report Form where used. If Form H-6 is used in conjunction with Form H-5, the Authorized Inspector's certification is not applicable.

HG-530 STAMPING OF BOILERS

07 HG-530.1 Stamping Requirements for Boilers Other Than Those Constructed Primarily of Cast Iron or Cast Aluminum (See HG-530.2)

(a) All boilers to which the Code Symbol is to be applied shall be built according to the rules of this Section by a manufacturer who is in possession of a Code Symbol Stamp and a valid Certificate of Authorization. Each boiler shall be stamped with the Code Symbol shown in Fig. HG-530.1 and with the following data:

(1) the boiler manufacturer's name, preceded by the words "Certified by"

(2) maximum allowable working pressure

A08 *(3)* safety or safety relief valve capacity (minimum), as determined according to HG-400.1(d) and HG-400.2(e)

(4) heating surface, as determined according to HG-403 (or power input for electric boilers)

(5) manufacturer's serial number

(6) year built

(7) maximum water temperature

NOTE: The year built may be incorporated into the serial number as a prefix consisting of the last two digits of the year.

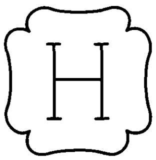
(b) Items (1) through (7) listed in (a) above, with the markings arranged substantially as shown in Fig. HG-530.2 or Fig. HG-530.3, shall be stamped with letters at least $\frac{5}{16}$ in. (8 mm) high [except as permitted in HG-530.1(d)] and in some conspicuous place on the boiler proper or on a nameplate at least $\frac{3}{64}$ in. (1.2 mm) thick permanently fastened to the boiler proper. The location of the stamping shall be as follows:

(1) Horizontal Tubular Flue Type Boilers: on the front head above the central rows of tubes or flues.

FIG. HG-530.2 STEAM AND WATER BOILERS 07

FORM OF STAMPING ON COMPLETED BOILERS OR THEIR NAMEPLATES

(Not Applicable for Boilers Constructed Primarily of Cast Iron)



Certified by

____
(Name of Manufacturer)
[1]MAWP, Steam _______
[1]MAWP, Water _______
[1]Maximum Water Temp. _______
[2]Heating surface _______ boiler
[3]Heating surface _______ water wall
[3]Heating surface _______ extended
[3,4]Ext HS generating cap _______
Minimum relief valve capacity _______
Manufacturer's serial no. _______________
[5]Year built _______________

GENERAL NOTE: Acceptable abbreviations to any of the stamp wording may be used.

NOTES:

(1) For steam only boilers, MAWP Water and Maximum Water Temperature markings are optional.

(2) Kilowatt power input for electric boilers.

(3) List each type of surface separately. May be omitted if type heating surface is not present.

(4) Generating capacity for extended heating surface [see HG-403(d)].

(5) May be omitted when year built is prefix to serial number (see HG-530.1).

(2) Locomotive Firebox, Compact, or Vertical Firetube Type Boilers: over or near the fire door or handhole or washout plug opening on the front end or side.

(3) Watertube Type Boilers: on a head of the top outlet drum. Waterwalls and headers shall carry identifying markings.

(4) Split-Section and Section Firebox Type Wrought Boilers: over or near the fire door or handhole or washout plug opening on the front end or side. Each section shall carry identifying markings.

(5) Scotch Type Boilers: on either side of the shell near the normal water level line adjacent to the front tubesheet.

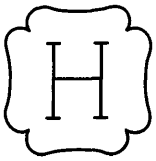
(c) On any of the above type boilers where there is not sufficient space in the places designated and on other types and new designs of boilers, the nameplate shall be located in a conspicuous place.

(d) When there is insufficient space for the nameplate required above, smaller letter dimensions may be used, provided

(1) stamping shall be as required in HG-530.1(a) and (b) above, and

FIG. HG-530.3 BOILERS SUITABLE FOR WATER ONLY

FORM OF STAMPING ON COMPLETED BOILERS OR THEIR NAMEPLATES
(Not Applicable for Boilers Constructed Primarily of Cast Iron)



Certified by
____
(Name of Manufacturer)
[1]MAWP, Water ________
[1]Maximum Water Temp. ________

[2]Heating surface ________ boiler
[3]Heating surface ________ water wall
[3]Heating surface ________ extended
[3,4]Ext HS generating cap ________
Minimum relief valve capacity ________
Manufacturer's serial no. ______________
[5]Year built ________________________

GENERAL NOTE: Acceptable abbreviations to any of the stamp wording may be used.

NOTES:
(1) For steam only boilers, MAWP Water and Maximum Water Temperature markings are optional.
(2) Kilowatt power input for electric boilers.
(3) List each type of surface separately. May be omitted if type heating surface is not present.
(4) Generating capacity for extended heating surface [see HG-403(d)].
(5) May be omitted when year built is prefix to serial number (see HG-530.1).

(2) character size shall be no smaller than $\frac{5}{32}$ in. (4 mm)

(e) The stamping or nameplate on the boiler proper shall not be covered with insulating or other material unless

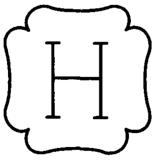
(1) the required markings are duplicated and stamped directly on the boiler casing in some conspicuous place using letters and numerals at least $\frac{5}{16}$ in. (8 mm) high

(2) an opening with a removable cover is provided in the jacket or other form of casing so that, when removed, the stamping or nameplate on the boiler proper can be viewed

(3) the required data are duplicated by stamping or marking with letters at least $\frac{1}{8}$ in. (3 mm) high on a nonferrous nameplate at least 3 in. × 4 in. (75 mm × 100 mm) size and permanently attaching the nameplate to the casing in some conspicuous place by mechanical means or by an adhesive system meeting the requirements of Appendix 3

FIG. HG-530.4 STEAM AND WATER BOILERS 07

FORM OF DATA CAST ON CAST IRON BOILER SECTIONS



Certified by
(1) (5)
Name of Manufacturer for
MAWP, Steam ________
MAWP, Water ________ (2)
(3)
(Pattern number)
(4)
(Casting date)

NOTE: (1) through (5) refer to HG-530.2(a)(1)–(a)(5); (5) is optional.

(f) The Code Symbol may be preapplied to a nameplate. The nameplate may be attached to the boiler after the final fabrication and examination sequence but before the hydrostatic test, provided the procedure for sequence of stamping is described in the manufacturer's accepted quality control system. The Code Symbol and manufacturer's serial number shall be stamped on nameplates but the other data may be stamped, etched, cast, or impressed thereon.

(g) The ASME Code Symbol Stamp(s) shall not be used by an organization to which it was not issued.

HG-530.2 Marking Requirements for Cast Iron or Cast Aluminum Boilers 07

(a) All boiler parts or sections to which the Code Symbol is to be applied shall be built according to the rules of this Section by a manufacturer[3] who is in possession of a Code Symbol Stamp and a valid Certificate of Authorization. Each boiler section, including end and intermediate cored sections, shall be cast with the Code Symbol shown in Fig. HG-530.1 and with the following data cast in letters or numerals at least $\frac{5}{16}$ in. (8 mm) high:

(1) the boiler or parts manufacturer's[3] name or acceptable abbreviation, preceded by the words "Certified by:" (or "Cert. by" on cast boiler sections only where space for marking is limited; the abbreviation "Cert. by" shall not be used on nameplates)

(2) maximum allowable working pressure[4]

(3) pattern number

(4) casting date

(5) the shop assembler's[5] name or acceptable abbreviation (if different from manufacturer)[6]

Arrangement of data cast on sections shall be substantially as shown in Fig. HG-530.4 for cast iron steam or hot water heating boilers or Fig. HG-530.5 for cast iron or cast aluminum hot water heating boilers.

---

[3] The foundry that casts the boiler parts or sections and that may shop assemble.

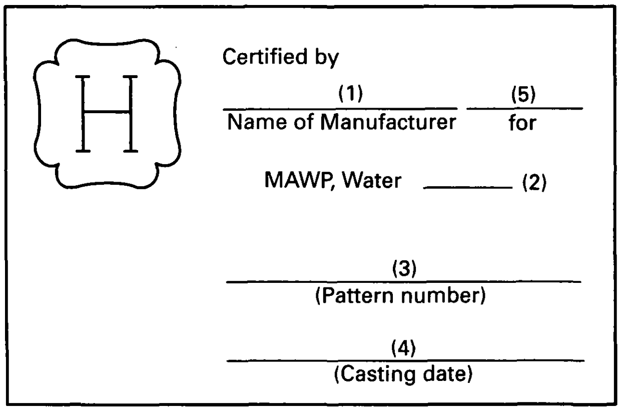
[4] May be stamped.

[5] The shop that assembles sections into boilers and that is in possession of a Code Symbol Stamp and valid Certificate of Authorization.

[6] Optional.

FIG. HG-530.5 BOILERS SUITABLE FOR WATER ONLY

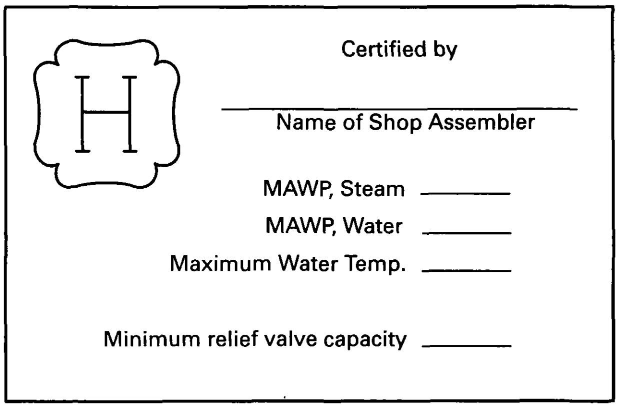
FORM OF DATA CAST ON CAST IRON BOILER SECTIONS



NOTE: (1) through (5) refer to HG-530.2(a)(1)–(a)(5); (5) is optional.

07 ### FIG. HG-530.6 STEAM AND WATER BOILERS

FORM OF STAMPING ON COMPLETED CAST IRON BOILERS OR THEIR NAMEPLATES



Other data may be cast on the sections. The marking "ASME" or "ASME standard" shall not be used.

(b) When the boiler size and number of sections have been decided, the completed boiler shall be marked with the Code Symbol shown in Fig. HG-530.1 and with the following data:

(1) the shop assembler's name preceded by the words "Certified by"

(2) maximum allowable working pressure

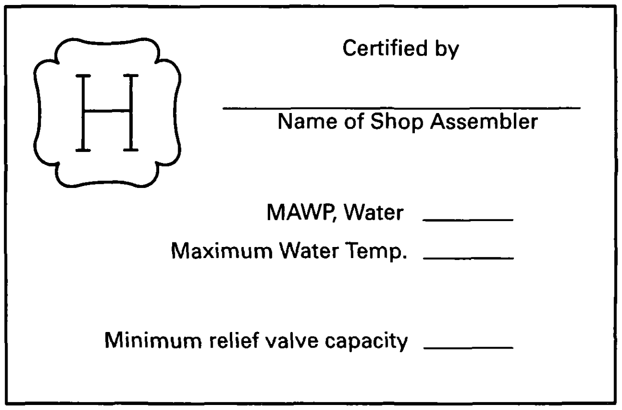
A08 *(3)* safety or safety relief valve capacity (minimum), as determined according to HG-400.1(d) and HG-400.2(e)

(4) maximum water temperature

(c) The markings for the completed boiler shall be arranged substantially as shown in Fig. HG-530.6 or Fig. HG-530.7.

FIG. HG-530.7 BOILERS SUITABLE FOR WATER ONLY

FORM OF STAMPING ON COMPLETED CAST IRON BOILERS OR THEIR NAMEPLATES



(d) Data for more than one size boiler in a model series may be listed on the nameplate. When different model numbers having the same number of sections and jacket length have different minimum safety or safety relief valve capacities, the highest value shall be listed. The following additional information shall be included for each size listed:

(1) boiler model number

(2) number of sections

(3) jacket length

(4) the statement: "To determine boiler size, count the number of sections or measure the jacket length"

(e) The provisions of (b) above shall be met utilizing one of the following methods:

(1) stamping the required markings on a nonferrous nameplate at least 3 in. × 4 in. (75 mm × 100 mm) in size and $\frac{3}{64}$ in. (1.2 mm) thick using letters and numerals at least $\frac{1}{8}$ in. (3 mm) high and permanently attaching the nameplate to the boiler proper in some conspicuous place. The nameplate shall not be covered with insulating or other material except that when a jacket or other form of casing is applied to a boiler, an opening with a removable cover shall be provided for viewing the required stamping.

(2) stamping the required markings directly into the boiler casing in some conspicuous place using letters and numerals at least $\frac{5}{16}$ in. (8 mm) high.

(3) stamping or marking the required data on a nonferrous or nonmetallic nameplate at least 3 in. × 4 in. (75 mm × 100 mm) in size using letters and numerals at least $\frac{1}{8}$ in. (3 mm) high and permanently attaching the nameplate to the casing in some conspicuous place by mechanical means or by an adhesive system. The nameplate and the adhesive system shall meet the requirements of Appendix 3.

HG-540.4 Quality Control System. Any Manufacturer or Assembler holding or applying for a Certificate of Authorization to use the H, HLW, or HV Stamp shall have, and demonstrate, a quality control system to establish that all Code requirements, including material, design, fabrication, examination (by the Manufacturer), inspection of boilers, vessels, parts (by the Authorized Inspector), pressure testing, and certification will be met. The quality control system shall be in accordance with the requirements of Appendix F, except for Cast Iron Boiler Certificate Holders. It must be in accordance with the requirements of Article 5 of Part HC.

HG-540.5 Evaluation for Authorization and Reauthorization. Before issuance or triennial renewal of a Certificate of Authorization for use of the H or HLW Stamp, the Manufacturer's facilities and organization are subject to a joint review by his Inspection Agency and an ASME Designee who is selected by the concerned legal jurisdiction, except that for H (cast iron) the review shall be yearly by an ASME Designee selected by ASME. A written description or checklist of the quality control system that identifies what documents and what procedures the Manufacturer will use to produce a Code item shall be available for review.

The purpose of the review is to evaluate the applicant's quality control system and its implementation. The applicant shall demonstrate sufficient administrative and fabrication functions of the system to show that he has the knowledge and ability to produce the Code items covered by his quality control system. Fabrication functions may be demonstrated using current work, a mock-up, or a combination of the two.

A written report to the Society shall be made jointly by the ASME Designee and the Inspection Agency employed by the Manufacturer to do his Code inspection. This report is then reviewed by the Subcommittee on Boiler and Pressure Vessel Accreditation, which will either issue a Certificate of Authorization or notify the applicant of deficiencies revealed by the review. In such a case, the applicant will be given an opportunity to explain or correct these deficiencies.

Certificates of Authorization will be endorsed to indicate the scope of activity authorized. Authorization may include field operations if the review team determines that these operations are adequately described in the quality control manual, and this determination is accepted by the Society.

Before issuance or renewal of a Certificate of Authorization for use of the HV stamp, the valve Manufacturer's facilities and organization are subject to a review by an ASME Designee. A written description or checklist of the quality control system, which identifies the documents and procedures the Manufacturer will use to produce Code safety and safety relief valves, shall be available for review. The ASME Designee shall make a written report to the Society, where the Subcommittee on Boiler and Pressure Vessel Accreditation will act on it as described above.

Before issuance or renewal of a Certificate of Authorization for use of the H (cast iron) Stamp to produce cast iron boilers, each Manufacturer (the foundry who casts the boiler parts or sections and who may shop assemble) or Assember is subject to review by an ASME Designee. A written description or checklist of the quality control system in accordance with the requirements of Part HC shall be available for review. The ASME Designee shall make a written report to the Society, where the Subcommittee on Boiler and Pressure Vessel Accreditation will act on it as described above.

HG-540.6 Authorization of Changes. The Manufacturer may at any time make changes in the quality control system concerning the methods of achieving results, subject to acceptance by the Authorized Inspector. For Manufacturers of multiple duplicate pressure vessels,[8] acceptance of these changes by the jurisdiction (if applicable) and an ASME Designee is also required. For Manufacturers of HV stamped safety and safety relief valves, such acceptance shall be by a representative from an ASME-designated organization.

For those areas where there is no jurisdiction, that function shall be performed by an ASME Designee selected by ASME. Where a jurisdiction does not review a Manufacturer's facility, that function shall be performed by an ASME Designee who is selected by the concerned legal jurisdiction. Where the jurisdiction is the Manufacturer's Inspection Agency, the joint review and joint report shall be made by the jurisdiction and an ASME Designee.

HG-540.7 Code Construction Before Receipt of Certificate of Authorization. When used to demonstrate his quality control system, a Manufacturer may start fabricating Code items before receipt of a Certificate of Authorization to use a Code Symbol Stamp under the following conditions.

(a) The fabrication is done with the participation of the Authorized Inspector and is subject to his acceptance.

(b) The activity is in conformance with the applicant's quality control system.

(c) The item is stamped with the appropriate Code Symbol and certified once the applicant receives his Certificate of Authorization from the Society.

HG-540.8 Regulations on Use of Code Symbol Stamps. The Boiler and Pressure Vessel Committee may at any time make such regulations concerning the issuance and use of Code Symbol Stamps as it deems appropriate, and all such regulations shall become binding upon the holders of any valid Certificates of Authorization.

---

[8] See HG-515.4 for additional requirements applicable to multiple, duplicate pressure vessel fabrication.

ARTICLE 6
INSTRUMENTS, FITTINGS, AND CONTROLS

HG-600 GENERAL

All instruments, fittings, and controls described in this Article shall be installed prior to operation.

HG-601 FOR STEAM HEATING BOILERS

HG-602 STEAM GAGES

(a) Each steam boiler shall have a steam gage or a compound steam gage connected to its steam space or to its water column or to its steam connection. The gage or piping to the gage shall contain a siphon or equivalent device that will develop and maintain a water seal that will prevent steam from entering the gage tube. The piping shall be so arranged that the gage cannot be shut off from the boiler except by a cock placed in the pipe at the gage and provided with a tee- or lever-handle arranged to be parallel to the pipe in which it is located when the cock is open. The gage connection boiler tapping, external siphon, or piping to the boiler shall not be less than NPS $\frac{1}{4}$ (DN 8). Where steel or wrought iron pipe or tubing is used, the boiler connection and external siphon shall be not less than NPS $\frac{1}{2}$ (DN 15). Ferrous and nonferrous tubing having inside diameters at least equal to that of standard pipe sizes listed above may be substituted for pipe.

(b) The scale on the dial of a steam boiler gage shall be graduated to not less than 30 psi (200 kPa) nor more than 60 psi (414 kPa). The travel of the pointer from 0 psi to 30 psi (0 kPa to 200 kPa) pressure shall be at least 3 in. (75 mm).

HG-603 WATER GAGE GLASSES

(a) Each steam boiler shall have one or more water gage glasses attached to the water column or boiler by means of valved fittings not less than NPS $\frac{1}{2}$ (DN 15), with the lower fitting provided with a drain valve of a type having an unrestricted drain opening not less than $\frac{1}{4}$ in. (6 mm) in diameter to facilitate cleaning. Gage glass replacement shall be possible with the boiler under pressure. Water glass fittings may be attached directly to a boiler.

Boilers having an internal vertical height of less than 10 in. (250 mm) may be equipped with a water level indicator of the Glass Bull's-Eye type provided the indicator is of sufficient size to show the water at both normal operating and low-water cutoff levels.

(b) The lowest visible part of the water gage glass shall be at least 1 in. (25 mm) above the lowest permissible water level recommended by the boiler Manufacturer. With the boiler operating at this lowest permissible water level, there shall be no danger of overheating any part of the boiler.

Each boiler shall be provided at the time of the manufacture with a permanent marker indicating the lowest permissible water level. The marker shall be stamped, etched, or cast in metal; or it shall be a metallic plate attached by rivets, screws, or welding; or it shall consist of material with documented tests showing its suitability as a permanent marking for the application. This marker shall be visible at all times. Where the boiler is shipped with a jacket, this marker may be located on the jacket.

NOTE: Transparent material other than glass may be used for the water gage provided that the material will remain transparent and has proved suitable for the pressure, temperature, and corrosive conditions expected in service.

(c) In electric boilers of the submerged electrode type, the water gage glass shall be so located to indicate the water levels both at startup and under maximum steam load conditions as established by the manufacturer.

(d) In electric boilers of the resistance element type, the lowest visible part of the water gage shall be located at least 1 in. (25 mm) above the lowest permissible water level specified by the Manufacturer. Each electric boiler of this type shall also be equipped with an automatic low-water cutoff on each boiler pressure vessel so located as to automatically cut off the power supply to the heating elements before the surface of the water falls below the lowest visible part of the water gage glass. **A08**

(e) Tubular water glasses on electric boilers having a normal water content not exceeding 100 gal (300 l) shall be equipped with a protective shield.

(f) A water level indicator using an indirect sensing method may be used in lieu of an operating water gauge glass; however, a water gauge glass must be installed and operable but may be shut off by valving. The water level

indicator must be attached to a water column or directly to the boiler by means of valved fittings not less than NPS ½ (DN 15). The device shall be provided with a drain valve of a type having an unrestricted drain opening not less than ¼ in. (6 mm) in diameter to facilitate cleaning. Service and replacement of internal parts and/or housing shall be possible with the boiler under pressure.

HG-604 WATER COLUMN AND WATER LEVEL CONTROL PIPES

(a) The minimum size of ferrous or nonferrous pipes connecting a water column to a steam boiler shall be NPS 1 (DN 25). No outlet connections, except for damper regulator, feedwater regulator, steam gages, or apparatus that does not permit the escape of any steam or water except for manually operated blowdowns, shall be attached to a water column or the piping connecting a water column to a boiler (see HG-705 for introduction of feedwater into a boiler). If the water column, gage glass, low-water fuel cutoff, or other water level control device is connected to the boiler by pipe and fittings, no shutoff valves of any type shall be placed in such pipe, and a cross or equivalent fitting to which a drain valve and piping may be attached shall be placed in the water piping connection at every right angle turn to facilitate cleaning. The water column drain pipe and valve shall be not less than NPS ¾ (DN 20).

(b) The steam connections to the water column of a horizontal firetube wrought boiler shall be taken from the top of the shell or the upper part of the head, and the water connection shall be taken from a point not above the center line of the shell. For a cast iron boiler, the steam connection to the water column shall be taken from the top of an end section or the top of the steam header, and the water connection shall be made on an end section not less than 6 in. (150 mm) below the bottom connection to the water gage glass.

A08 HG-605 PRESSURE CONTROL

Each automatically fired steam boiler shall be protected from overpressure by two pressure-operated controls. These controls shall conform to UL 353, Standard for Limit Controls, and shall be accepted by a nationally recognized testing agency.

(a) Each individual automatically fired steam boiler shall have a safety limit control that will cut off the fuel supply to prevent steam pressure from exceeding the 15 psi (100 kPa) maximum allowable working pressure of the boiler. Each control shall be constructed to prevent a pressure setting above 15 psi (100 kPa).

(b) Each individual steam boiler shall have a control that will cut off the fuel supply when the pressure reaches an operating limit, which shall be less than the maximum allowable pressure.

(c) Shutoff valves of any type shall not be placed in the steam pressure connection between the boiler and the controls described in (a) and (b) above. These controls shall be protected with a siphon or equivalent means of maintaining a water seal that will prevent steam from entering the control. The control connection boiler tapping, external siphon, or piping to the boiler shall be not less than NPS ¼ (DN 8). When a control incorporating a mercury switch is mounted on a siphon, the loop of the siphon shall be in a plane that is 90 deg (1.57 rad) from the plane of the switch.

(1) Steam pressure supply connections to a single pressure control using pipe of nonferrous material shall be not less than NPS ¼ (DN 8) for lengths up to and including 5 ft (1.5 m), and not less than NPS ½ (DN 15) for lengths over 5 ft (1.5 m).

(2) Steam pressure supply connections to a single pressure control using pipe of ferrous material shall be not less than NPS ½ (DN 15) for lengths up to and including 5 ft (1.5 m), and not less than NPS 1 (DN 25) for lengths over 5 ft (1.5 m).

(3) Pressure controls should have separate pressure connections; however, manifolding is permitted. When multiple controls are fed from a manifold, the manifold and common source connection to the boiler, for pipe of nonferrous material, shall be not less than NPS ½ (DN 15) for lengths up to and including 5 ft (1.5 m), and not less than NPS ¾ (DN 20) for lengths over 5 ft (1.5 m). For manifolds using ferrous material, the manifold and common source connection to the boiler, shall be not less than NPS ¾ (DN 20) for lengths up to and including 5 ft (1.5 m) and not less than NPS 1¼ (DN 32) for lengths over 5 ft (1.5 m). Individual controls are to be piped from the manifold according to the provisions of (2) and (3) above.

(4) Tubing suitable for the temperatures and pressures involved, having an inside diameter at least equal to the required standard pipe sizes, may be substituted for pipe.

HG-606 AUTOMATIC LOW-WATER FUEL CUTOFF AND/OR WATER FEEDING DEVICE

(a) Each automatically fired steam or vapor-system A08 boiler shall have an automatic low-water fuel cutoff, conforming to UL 353, Standard for Limit Controls, and accepted by a nationally recognized testing agency. This device shall be so located as to automatically cut off the fuel supply before the surface of the water falls below the lowest visible part of the water gage glass. If a water feeding device is installed, it shall be so constructed that the water inlet valve cannot feed water into the boiler

through the float chamber and so located as to supply requisite feedwater.

(b) Such a fuel cutoff or water feeding device may be attached directly to a boiler. A fuel cutoff or water feeding device may also be installed in the tapped openings available for attaching a water glass directly to a boiler, provided the connections are made to the boiler with nonferrous tees or Y's not less than NPS ½ (DN 15) between the boiler and the water glass so that the water glass is attached directly and as close as possible to the boiler; the run of the tee or Y shall take the water glass fittings, and the side outlet or branch of the tee or Y shall take the fuel cutoff or water feeding device. The ends of all nipples shall be reamed to full-size diameter.

(c) Fuel cutoffs and water feeding devices embodying a separate chamber shall have a vertical drain pipe and a blowoff valve not less than NPS ¾ (DN 20), located at the lowest point in the water equalizing pipe connections so that the chamber and the equalizing pipe can be flushed and the device tested.

HG-607 MODULAR STEAM HEATING BOILERS

(a) Each module of a modular steam heating boiler shall be equipped with

(1) steam gage, see HG-602

(2) water gage glass, see HG-603

(3) a pressure control that will cut off the fuel supply when the pressure reaches an operating limit, which shall be less than the maximum allowable pressure

(4) low water cutoff, see HG-606

(b) The assembled modular steam boiler shall also be equipped with a safety limit control that will cut off the fuel supply to prevent steam pressure from exceeding the 15 psi (100 kPa) maximum allowable working pressure of the boiler. The control shall be constructed to prevent a pressure setting above 15 psi (100 kPa).

HG-610 FOR HOT WATER HEATING OR HOT WATER SUPPLY BOILERS

HG-611 PRESSURE OR ALTITUDE GAGES

(a) Each hot water heating or hot water supply boiler shall have a pressure or altitude gage connected to it or to its flow connection in such a manner that it cannot be shut off from the boiler except by a cock with tee or lever handle, placed on the pipe near the gage. The handle of the cock shall be parallel to the pipe in which it is located when the cock is open.

(b) The scale on the dial of the pressure or altitude gage shall be graduated approximately to not less than 1½ nor more than 3½ times the pressure at which the safety relief valve is set.

(c) Piping or tubing for pressure- or altitude-gage connections shall be of nonferrous metal when smaller than NPS 1 (DN 25).

HG-612 THERMOMETERS

Each hot water heating or hot water supply boiler shall have a thermometer so located and connected that it shall be easily readable. The thermometer shall be so located that it shall at all times indicate the temperature of the water in the boiler at or near the outlet.

HG-613 TEMPERATURE CONTROL

A08

Each automatically fired hot water heating or hot water supply boiler shall be protected from over-temperature by two temperature-operated controls. These temperature control devices shall conform to UL 353, Standard for Limit Controls, and shall be accepted by a nationally recognized testing agency.

(a) Each individual automatically fired hot water heating or hot water supply boiler shall have a high temperature limit control that will cut off the fuel supply to prevent water temperature from exceeding its marked maximum water temperature at the boiler outlet. This control shall be constructed to prevent a temperature setting above the maximum.

(b) Each individual hot water heating or hot water supply boiler shall have a control that will cut off the fuel supply when the system water temperature reaches a preset operating temperature, which shall be less than the maximum water temperature.

HG-614 LOW-WATER FUEL CUTOFF

(a) Each automatically fired hot water boiler with heat input greater than 400,000 Btu/hr (117 kW) shall have an automatic low-water fuel cutoff that has been designed for hot water service conforming to UL 353, Standard for Limit Controls, and accepted by a nationally recognized testing agency. This device shall be so located as to automatically cut off the fuel supply when the surface of the water falls to the level established in (b) below (see Fig. HG-703.2). A08

(b) As there is no normal waterline to be maintained in a hot water boiler, any location of the low-water fuel cutoff above the lowest safe permissible water level established by the boiler manufacturer is satisfactory.

(c) A coil-type boiler or a watertube boiler with heat input greater than 400,000 Btu/hr (117 kW) requiring forced circulation to prevent overheating of the coils or tubes shall have a flow-sensing device installed in lieu of

the low-water fuel cutoff required in (a) above to automatically cut off the fuel supply when the circulating flow is interrupted.

(d) A means shall be provided for testing the operation of the external low-water fuel cutoff without resorting to draining the entire system. Such means shall not render the device inoperable except as described as follows. If the means temporarily isolates the device from the boiler during this testing, it shall automatically return to its normal position. The connection may be so arranged that the device cannot be shut off from the boiler except by a cock placed at the device and provided with a tee or lever-handle arranged to be parallel to the pipe in which it is located when the cock is open.

HG-615 MODULAR HOT WATER HEATING BOILERS

(a) Each module of a modular hot water heating boiler shall be equipped with

(1) pressure/altitude gage, see HG-611

(2) thermometer, see HG-612

(3) temperature control that will cut off the fuel supply when the temperature reaches an operating limit, which shall be less than the maximum allowable temperature

(b) The assembled modular hot water heating boiler shall also be equipped with

(1) a safety limit control that will cut off the fuel supply to prevent the water temperature from exceeding the maximum allowable temperature at the boiler outlet. The control shall be constructed to prevent a temperature setting above the maximum. This control shall be located within 3 ft. (1.0 m) of the fitting connecting the last module to the heating supply piping

(2) low water fuel cutoff, see HG-614

HG-620 FOR ALL BOILERS

HG-621 INSTRUMENTS, FITTINGS, AND CONTROLS MOUNTED INSIDE BOILER JACKETS

Any or all instruments, fittings, and controls required by these rules may be installed inside of boiler jackets

INTENTIONALLY LEFT BLANK

by providing substantial anchorage at suitable points and by providing swing joints when boilers are installed in batteries, so there will be no undue strain transmitted to the boilers. See Figs. HG-703.1(a), HG-703.1(b), and HG-703.2 for typical schematic arrangements of piping incorporating strain absorbing joints for steam and hot water heating boilers.

HG-703.2 Return Pipe Connections

(a) The return pipe connections of each boiler supplying a gravity return steam heating system shall be so arranged as to form a loop substantially as shown in Fig. HG-703.1(b) so that the water in each boiler cannot be forced out below the safe water level.

(b) For hand-fired boilers with a normal grate line, the recommended pipe sizes detailed as "A" in Fig. HG-703.1 are NPS 1½ (DN 40) for 4 ft^2 (0.37 m^2) or less firebox area at the normal grate line, NPS 2½ (DN 65) for areas more than 4 ft^2 (0.37 m^2) up to 14.9 ft^2 (1.4 m^2), and NPS 4 (DN 100) for 15 ft^2 (1.4 m^2) or more.

(c) For automatically fired boilers that do not have a normal grate line, the recommended pipe sizes detailed as "A" in Fig. HG-703.1 are NPS 1½ (DN 40) for boilers with minimum safety valve relieving capacity 250 lb/hr (113 kg/hr) or less, NPS 2½ (DN 65) for boilers with minimum safety valve relieving capacity from 251 lb/hr (114 kg/hr) to 2,000 lb/hr (900 kg/hr), inclusive, and NPS 4 (DN 100) for boilers with more than 2,000 lb/hr (900 kg/hr) minimum safety valve relieving capacity.

(d) Provision shall be made for cleaning the interior of the return piping at or close to the boiler. Washout openings may be used for return pipe connections and the washout plug placed in a tee or a cross so that the plug is directly opposite and as close as possible to the opening in the boiler.

A08 HG-705 FEEDWATER AND MAKEUP WATER CONNECTIONS

(a) Steam Boilers. Feedwater or water treatment shall be introduced into a boiler through the return piping system. Alternatively, feedwater or water treatment may be introduced through an independent connection. The water flow from the independent connection shall not discharge directly against parts of the boiler exposed to direct radiant heat from the fire. Feedwater or water treatment shall not be introduced through openings or connections provided for inspection or cleaning, safety valve, water column, water gage glass, or pressure gage. The feedwater pipe shall be provided with a check valve (or a backflow preventer containing a check valve[3]) near the boiler. A stop valve or cock shall be installed either upstream or downstream of the check valve (or backflow preventer containing a check valve[3]).

(b) Hot Water Boilers. Makeup water may be introduced into a boiler through the piping system or through an independent connection. The water flow from the independent connection shall not discharge directly against parts of the boiler exposed to direct radiant heat from the fire. Makeup water shall not be introduced through openings or connections provided exclusively for inspection or cleaning, safety relief valve, pressure gage, or temperature gage. The makeup water pipe shall be provided with a check valve (or a backflow preventer containing a check valve[3]) near the boiler. A stop valve or cock shall be installed either upstream or downstream of the check valve (or backflow preventer containing a check valve[3]).

(c) The minimum pressure rating of all check valves, stop valves, cocks, or backflow preventers with check valve(s) shall be at least equal to the pressure stamped upon the boiler, and the temperature rating of such check valves, stop valves, cocks, or backflow preventers including all internal components, shall be not less than 250°F (120°C).

HG-707 OIL HEATERS

(a) A heater for oil or other liquid harmful to boiler operation shall not be installed directly in the steam or water space within a boiler.

(b) Where an external type heater for such service is used, means shall be provided to prevent the introduction into the boiler of oil or other liquid harmful to boiler operation.

HG-708 STORAGE TANKS FOR HOT WATER SUPPLY SYSTEMS

If a system is to utilize a storage tank that exceeds the capacity exception of HLW-101.2(c), the tank shall be constructed in accordance with the rules of Part HLW; Section VIII, Division 1; or Section X. For tanks constructed to Section X, the maximum allowable temperature marked on the tank shall equal or exceed the maximum water temperature marked on the boiler.

HG-709 PROVISIONS FOR THERMAL EXPANSION IN HOT WATER SYSTEMS

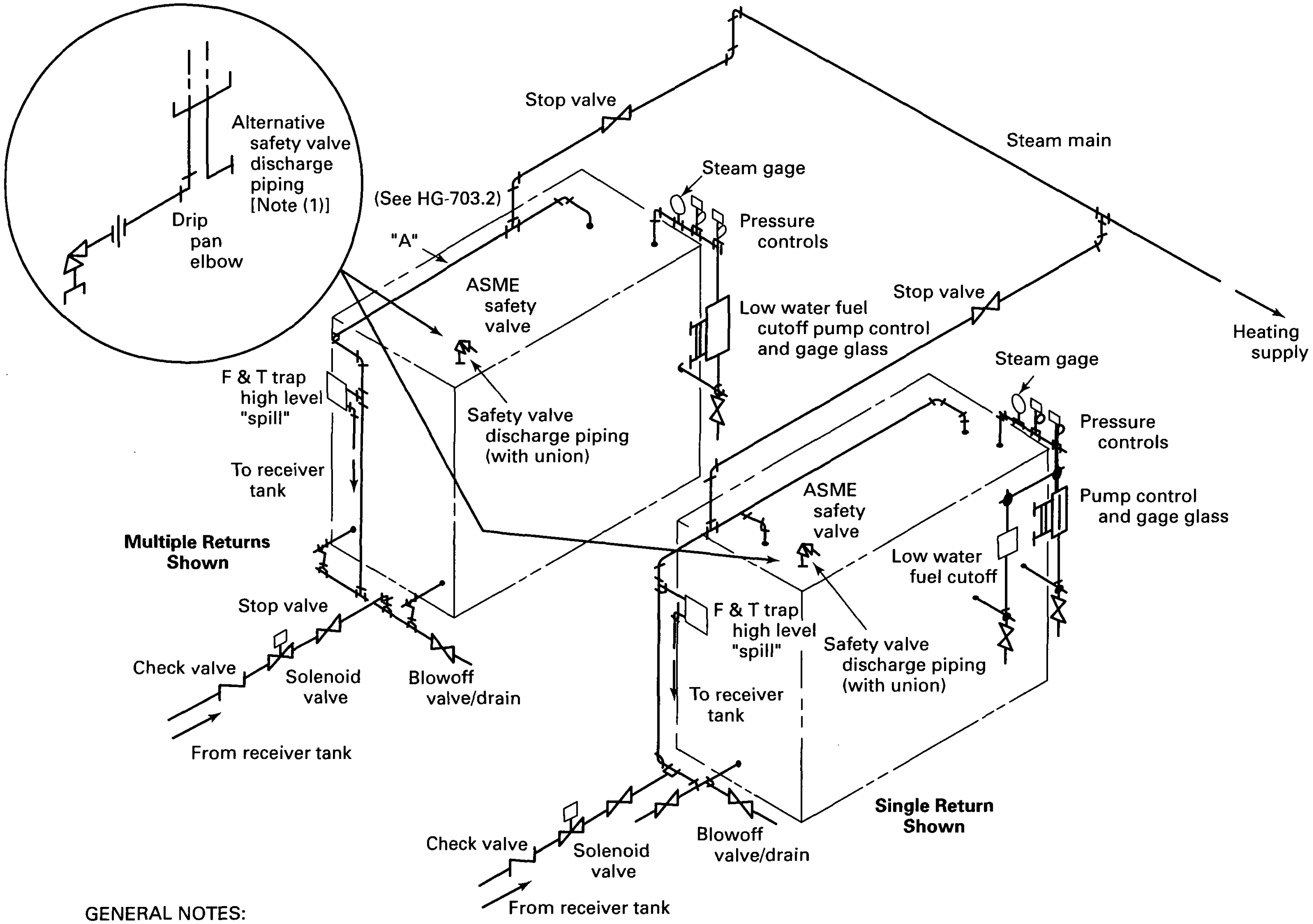
All hot water heating systems incorporating hot water tanks or fluid relief columns shall be so installed as to prevent freezing under normal operating conditions.

HG-709.1 Heating Systems With Open Expansion Tank. An indoor overflow from the upper portion of the expansion tank shall be provided in addition to an open vent, the indoor overflow to be carried within the building to a suitable plumbing fixture or the basement.

---

[3] Plumbing codes may require the installation of a reduced pressure principle backflow preventer on a boiler when the makeup water source is from a potable water supply.

FIG. HG-703.1(a) STEAM BOILERS IN BATTERY — PUMPED RETURN — ACCEPTABLE PIPING INSTALLATION



GENERAL NOTES:

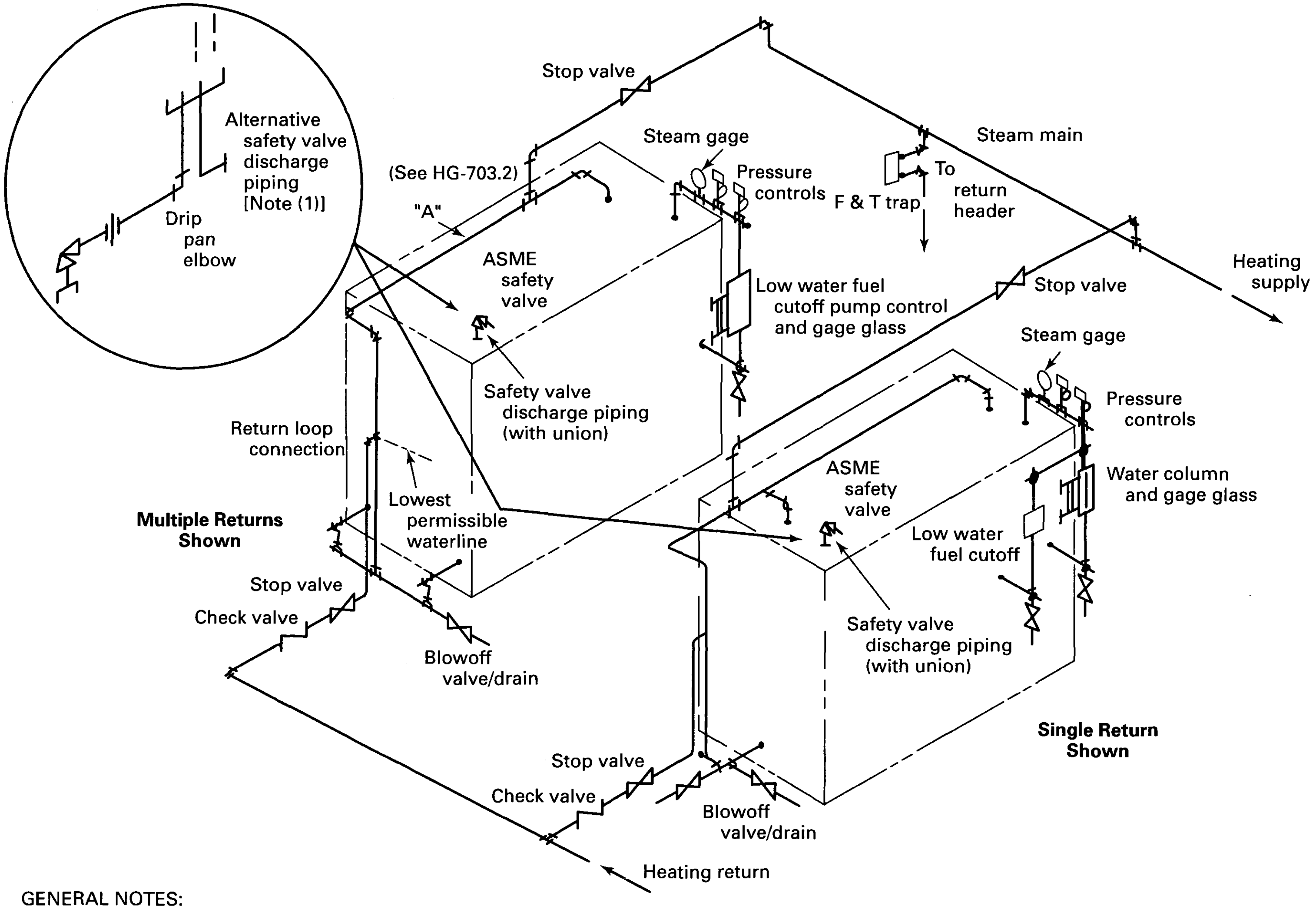
(a) Return connections shown for a multiple boiler installation may not always insure that the system will operate properly. In order to maintain proper water levels in multiple boiler installations, it may be necessary to install supplementary controls or suitable devices.

(b) Plumbing codes may require the installation of a reduced pressure principle backflow preventer on a boiler when the makeup water source is from a potable water supply.

NOTE:

(1) Recommended for 1 in. (DN 25) and larger safety valve discharge.

FIG. HG-703.1(b) STEAM BOILERS IN BATTERY — GRAVITY RETURN — ACCEPTABLE PIPING INSTALLATION



GENERAL NOTES:

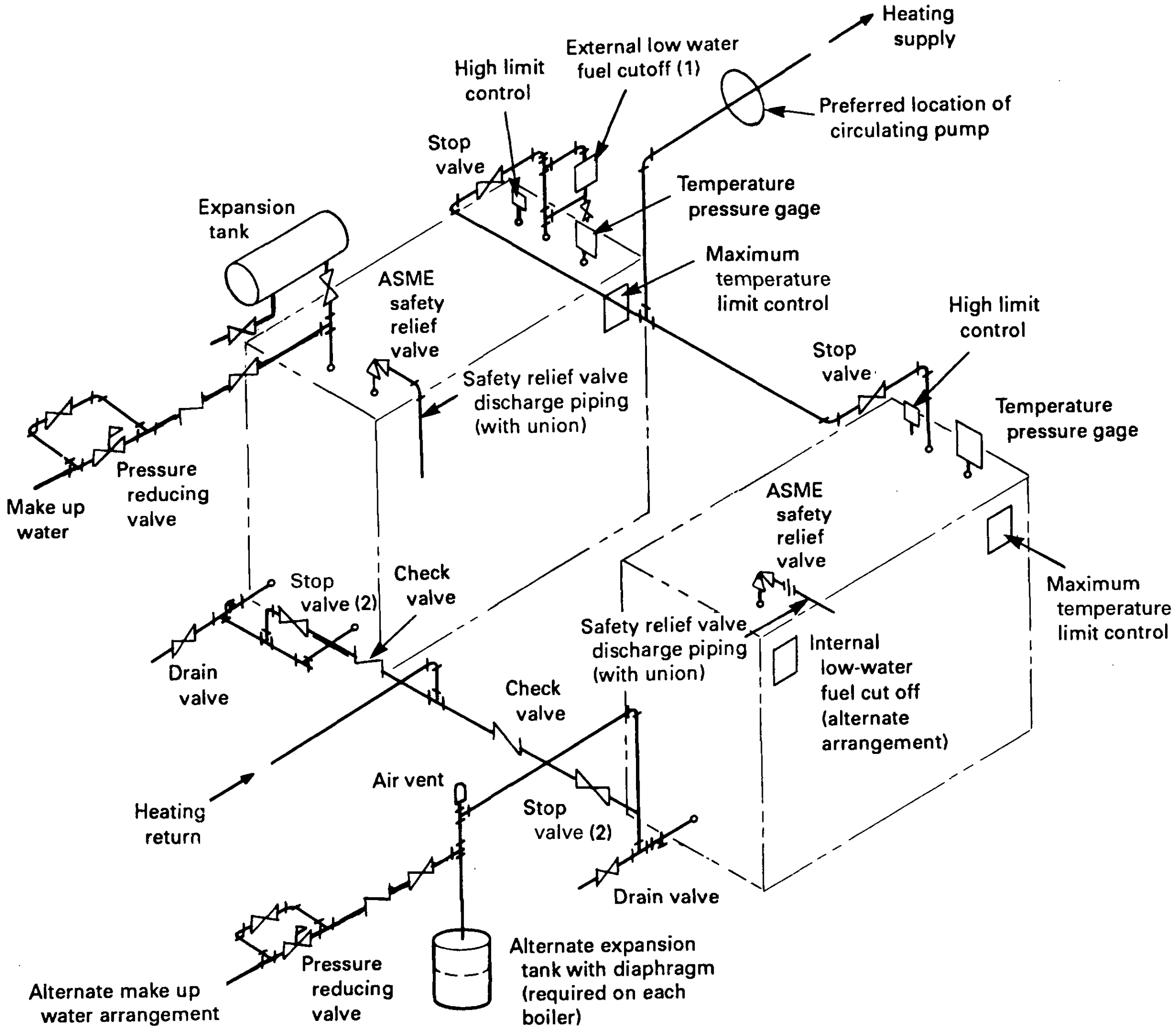
(a) Return connections shown for a multiple boiler installation may not always insure that the system will operate properly. In order to maintain proper water levels in multiple boiler installations, it may be necessary to install supplementary controls or suitable devices.

(b) Plumbing codes may require the installation of a reduced pressure principle backflow preventer on a boiler when the makeup water source is from a potable water supply.

NOTE:

(1) Recommended for 1 in. (DN 25) and larger safety valve discharge.

FIG. HG-703.2 HOT WATER BOILERS IN BATTERY — ACCEPTABLE PIPING INSTALLATION


Heating supply
External low water fuel cutoff (1)
High limit control
Preferred location of circulating pump
Stop valve
Temperature pressure gage
Expansion tank
Maximum temperature limit control
ASME safety relief valve
High limit control
Stop valve
Safety relief valve discharge piping (with union)
Temperature pressure gage
Pressure reducing valve
Make up water
ASME safety relief valve
Stop valve (2)
Check valve
Maximum temperature limit control
Safety relief valve discharge piping (with union)
Internal low-water fuel cut off (alternate arrangement)
Drain valve
Check valve
Air vent
Heating return
Stop valve (2)
Drain valve
Alternate expansion tank with diaphragm (required on each boiler)
Pressure reducing valve
Alternate make up water arrangement

GENERAL NOTE: Plumbing codes may require the installation of a reduced pressure principle backflow preventer on a boiler when the makeup water source is from a potable water supply.

NOTES:

(1) Recommended control. See HG-614. Acceptable shutoff valves or cocks in the connecting piping may be installed for convenience of control testing and/or service.

(2) The common return header stop valves may be located on either side of the check valves.

A08 **HG-709.2 Closed Heating Systems.** An expansion tank shall be installed that will be consistent with the volume and capacity of the system. If the system is designed for a working pressure of 30 psi (200 kPa) or less, the tank shall be suitably designed for a minimum hydrostatic test pressure of 75 psi (520 kPa). Expansion tanks for systems designed to operate above 30 psi (200 kPa) shall be constructed in accordance with Section VIII, Division 1. Alternatively, a tank built to Section X requirements may be used if the pressure and temperature ratings of the tank are equal to or greater than the pressure and temperature ratings of the system. Provisions shall be made for draining the tank without emptying the system, except for prepressurized tanks.

The minimum capacity of the closed type expansion tank may be determined from Table HG-709.2 or from the following formula where the necessary information is available:

(U.S. Customary Units)

$$V_t = [(0.00041T - 0.0466)V_s]/[(P_a/P_f) - (P_a/P_o)]$$

(SI Units)

$$V_t = [(0.000738T - 0.03348)V_s]/[(P_a/P_f) - (P_a/P_o)]$$

where

07
A08

TABLE HF-300.2
MAXIMUM ALLOWABLE STRESS VALUES FOR NONFERROUS MATERIALS, ksi
(multiply by 1000 to obtain psi)

Spec. No.	Alloy Designation UNS No.	Product Form	Class/Condition/Temper	P-No.	External Pressure Chart	Spec. Min. Tensile Strength, ksi	Spec. Min. Yield Strength, ksi	Note(s)	Maximum Allowable Stress Value, ksi								
									Up To 100°F	150	200	250	300	350	400	450	500
Aluminum																	
SB-209	A95052	Sheet and Plate	H32 wld.	22	NFA-8	25.0	9.5	. . .	5.0	5.0	5.0	5.0	4.8	. . .	. . .	. . .	. . .
SB-209	A96061	Sheet and Plate	T6 wld.	23	NFA-12	24	8	. . .	4.8	4.8	4.8	4.7	4.5	. . .	. . .	. . .	. . .
SB-209	A96061	Sheet and Plate	T651 wld.	23	NFA-12, 13	24	8	. . .	4.8	4.8	4.8	4.7	4.5	. . .	. . .	. . .	. . .
SB-210	A93003	Drawn Seamless Tube	0	21	NFA-1	14	5	. . .	2.8	2.8	2.6	2.3	2.1	. . .	. . .	. . .	. . .
SB-210	A95052	Drawn Seamless Tube	H32 wld.	22	NFA-12	25	10	. . .	5.0	5.0	5.0	5.0	4.8	. . .	. . .	. . .	. . .
SB-210	A96061	Drawn Seamless Tube	T6	23	NFA-12, 13	42	35	(4)	8.4	8.4	8.4	8.2	7.0	. . .	. . .	. . .	. . .
SB-210	A96061	Drawn Seamless Tube	T6	23	NFA-12, 13	24	. . .	(11)	4.8	4.8	4.8	4.7	4.0	. . .	. . .	. . .	. . .
SB-210	A96061	Drawn Seamless Tube	T6 wld.	23	NFA-12, 13	24	8	. . .	4.8	4.8	4.8	4.7	4.5	. . .	. . .	. . .	. . .
SB-211	A96061	Bar, Rod, Wire	T6 wld.	23	NFA-12	24	8	. . .	4.8	4.8	4.8	4.7	4.5	. . .	. . .	. . .	. . .
SB-211	A96061	Bar, Rod, Wire	T651 wld.	23	NFA-12, 13	24	8	. . .	4.8	4.8	4.8	4.7	4.5	. . .	. . .	. . .	. . .
SB-221	A96061	Extrude Bar, Rod and Shapes	T6 wld.	23	NFA-12, 13	24	8	. . .	4.8	4.8	4.8	4.7	4.5	. . .	. . .	. . .	. . .
SB-241	A95052	Seamless Pipe and Seamless Extruded Tube	H32 wld.	22	NFA-8	25	10	. . .	5.0	5.0	5.0	5.0	4.8	. . .	. . .	. . .	. . .
SB-241	A96061	Seamless Pipe and Seamless Extruded Tube	T6 wld.	23	NFA-12, 13	24	8	. . .	4.8	4.8	4.8	4.7	4.5	. . .	. . .	. . .	. . .
Aluminum Bronze																	
SB-111	C60800	Smls. Condenser Tubes	Annealed/061	35	NFC-2	50	19	. . .	10.0	10.0	10.0	10.0	10.0	9.9	. . .	. . .	. . .
Copper																	
SB-42	C10200	Pipe	Annealed/061	31	NFC-1	30	9	(1)	6.0	5.1	4.9	4.8	4.7	4.0	3.0	. . .	. . .
SB-42	C10200	Pipe	Hard Drawn/H80 - ⅛ in. to 2 in. NPS, incl.	31	NFC-4	45	40	(1)(2)	9.0	9.0	9.0	9.0	8.8	8.3	4.3	. . .	. . .
SB-42	C10200	Pipe	Light Drawn/H55 - 2½ in. to 12 in. NPS, incl.	31	NFC-3	36	30	(1)(2)	7.2	7.2	7.2	7.2	7.0	6.8	6.6	. . .	. . .
SB-42	C12000	Pipe	Annealed/061	31	NFC-1	30	9	(1)	6.0	5.1	4.9	4.8	4.7	4.0	3.0	. . .	. . .
SB-42	C12000	Pipe	Hard Drawn/H80 - ⅛ in. to 2 in. NPS, incl.	31	NFC-4	45	40	(1)(2)	9.0	9.0	9.0	9.0	8.8	8.3	4.3	. . .	. . .
SB-42	C12000	Pipe	Light Drawn/H55 - 2½ in. to 12 in. NPS, incl.	31	NFC-3	36	30	(1)(2)	7.2	7.2	7.2	7.2	7.0	6.8	6.6	. . .	. . .
SB-42	C12200	Pipe	Annealed/061	31	NFC-1	30	9	(1)	6.0	5.1	4.9	4.8	4.7	4.0	3.0	. . .	. . .
SB-42	C12200	Pipe	Hard Drawn/H80 - ⅛ in. to 2 in. NPS, incl.	31	NFC-4	45	40	(1)(2)	9.0	9.0	9.0	9.0	8.8	8.3	4.3	. . .	. . .

07
A08

TABLE HF-300.2
MAXIMUM ALLOWABLE STRESS VALUES FOR NONFERROUS MATERIALS, ksi
(multiply by 1000 to obtain psi)

Spec. No.	Alloy Designation UNS No.	Product Form	Class/Condition/Temper	P-No.	External Pressure Chart	Spec. Min. Tensile Strength, ksi	Spec. Min. Yield Strength, ksi	Note(s)	Maximum Allowable Stress Value, ksi								
									Up To 100°F	150	200	250	300	350	400	450	500
Copper (Cont'd)																	
SB-42	C12200	Pipe	Light Drawn/H55 - 2½ in. to 12 in. NPS, incl.	31	NFC-3	36	30	(1)(2)	7.2	7.2	7.2	7.2	7.0	6.8	6.6	...	...
SB-75	C10200	Smls. Tubes	Annealed/050/060	31	NFC-1	30	9	(1)	6.0	5.1	4.9	4.8	4.7	4.0	3.0	...	...
SB-75	C10200	Smls. Tubes	Light Drawn/H55	31	NFC-3	36	30	(1)(2)	7.2	7.2	7.2	7.2	7.0	6.8	6.6	...	...
SB-75	C10200	Smls. Tubes	Hard Drawn/H80	31	NFC-4	45	40	(1)(2)	9.0	9.0	9.0	9.0	8.8	8.3	4.3	...	...
SB-75	C12000	Smls. Tubes	Annealed/050/060	31	NFC-1	30	9	(1)	6.0	5.1	4.9	4.8	4.7	4.0	3.0	...	...
SB-75	C12000	Smls. Tubes	Light Drawn/H55	31	NFC-3	36	30	(1)(2)	7.2	7.2	7.2	7.2	7.0	6.8	6.6	...	...
SB-75	C12000	Smls. Tubes	Hard Drawn/H80	31	NFC-4	45	40	(1)(2)	9.0	9.0	9.0	9.0	8.8	8.3	4.3	...	...
SB-75	C12200	Smls. Tubes	Annealed/050/060	31	NFC-1	30	9	(1)	6.0	5.1	4.9	4.8	4.7	4.0	3.0	...	...
SB-75	C12200	Smls. Tubes	Light Drawn/H55	31	NFC-3	36	30	(1)(2)	7.2	7.2	7.2	7.2	7.0	6.8	6.6	...	...
SB-75	C12200	Smls. Tubes	Hard Drawn/H80	31	NFC-4	45	40	(1)(2)	9.0	9.0	9.0	9.0	8.8	8.3	4.3	...	...
SB-111	C10200	Smls. Condenser Tubes	Light Drawn/H55	31	NFC-6	36	30	(1)	7.2	7.2	7.2	7.2	7.0	6.8	6.6	...	...
SB-111	C10200	Smls. Condenser Tubes	Hard Drawn/H80	31	NFC-4	45	40	(1)	9.0	9.0	9.0	9.0	8.8	8.3	4.3	...	...
SB-111	C12000	Smls. Condenser Tubes	Light Drawn/H55	31	NFC-6	36	30	(1)	7.2	7.2	7.2	7.2	7.0	6.8	6.6	...	...
SB-111	C12000	Smls. Condenser Tubes	Hard Drawn/H80	31	NFC-4	45	40	(1)	9.0	9.0	9.0	9.0	8.8	8.3	4.3	...	...
SB-111	C12200	Smls. Condenser Tubes	Light Drawn/H55	31	NFC-6	36	30	(1)	7.2	7.2	7.2	7.2	7.0	6.8	6.6	...	...
SB-111	C12200	Smls. Condenser Tubes	Hard Drawn/H80	31	NFC-4	45	40	(1)	9.0	9.0	9.0	9.0	8.8	8.3	4.3	...	...
SB-111	C14200	Smls. Condenser Tubes	Light Drawn/H55	31	NFC-6	36	30	(1)	7.2	7.2	7.2	7.2	7.0	6.8	6.6	...	...
SB-111	C14200	Smls. Condenser Tubes	Hard Drawn/H80	31	NFC-4	45	40	(1)	9.0	9.0	9.0	9.0	8.8	8.3	4.3	...	...
SB-152	C10200	Plate, Sheet, Strip, & Bar	Hot Rolled/025, Annealed	31	NFC-1	30	10	(1)	6.0	5.6	5.4	5.2	5.0	4.0	3.0	...	...
SB-152	C10400	Plate, Sheet, Strip	Hot Rolled/025, Annealed	31	NFC-1	30	10	(1)	6.0	5.6	5.4	5.2	5.0	4.0	3.0	...	...
SB-152	C10500	Plate, Sheet, Strip	Hot Rolled/025, Annealed	31	NFC-1	30	10	(1)	6.0	5.6	5.4	5.2	5.0	4.0	3.0	...	...
SB-152	C10700	Plate, Sheet, Strip	Hot Rolled/025, Annealed	31	NFC-1	30	10	(1)	6.0	5.6	5.4	5.2	5.0	4.0	3.0	...	...
SB-152	C11000	Plate, Sheet, Strip, & Bar	Hot Rolled/025, Annealed	31	NFC-1	30	10	(1)	6.0	5.6	5.4	5.2	5.0	4.0	3.0	...	...
SB-152	C12200	Plate, Sheet, Strip	Hot Rolled/025, Annealed	31	NFC-1	30	10	(1)	6.0	5.6	5.4	5.2	5.0	4.0	3.0	...	...
SB-152	C12300	Plate, Sheet, Strip, & Bar	Hot Rolled/025, Annealed	31	NFC-1	30	10	(1)	6.0	5.6	5.4	5.2	5.0	4.0	3.0	...	...
SB-152	C14200	Plate, Sheet, Strip	Hot Rolled/025, Annealed	31	NFC-1	30	10	(1)	6.0	5.6	5.4	5.2	5.0	...	...	...	...
SB-283	C37700	Forging Brass	As Forged/M10/M11	...	...	46	15	(3)(4)	9.2	9.2	9.0	...	...	...	...	...	...
SB-395	C10200	Smls. Tubes	Light Drawn/H55	31	NFC-6	36	30	(1)(2)	7.2	7.2	7.2	7.2	7.0	6.8	6.6	...	...
SB-395	C12000	Smls. Tubes	Light Drawn/H55	31	NFC-6	36	30	(1)(2)	7.2	7.2	7.2	7.2	7.0	6.8	6.6	...	...
SB-395	C12200	Smls. Tubes	Light Drawn/H55	31	NFC-6	36	30	(1)(2)	7.2	7.2	7.2	7.2	7.0	6.8	6.6	...	...
SB-395	C14200	Smls. Tubes	Light Drawn/H55	31	NFC-6	36	30	(1)(2)	7.2	7.2	7.2	7.2	7.0	6.8	6.6	...	...

TABLE HF-300.2
MAXIMUM ALLOWABLE STRESS VALUES FOR NONFERROUS MATERIALS, ksi (CONT'D)
(multiply by 1000 to obtain psi)

Spec. No.	Alloy Designation UNS No.	Product Form	Class/Condition/Temper	P-No.	External Pressure Chart	Spec. Min. Tensile Strength, ksi	Spec. Min. Yield Strength, ksi	Note(s)	Maximum Allowable Stress Value, ksi								
									Up To 100°F	150	200	250	300	350	400	450	500
Copper-Silicon																	
SB-96	C65500	Plate & Sheet	Annealed/061	33	NFC-2	50	18	(5)	10.0	10.0	10.0	10.0	10.0	5.0	3.7	...	...
SB-98	C65500	Rods	Soft Anneal/060	33	...	52	15	(5)	10.0	10.0	9.9	9.8	9.7	5.0	3.7	...	...
SB-98	C65500	Rods	Quarter Hard/H01	33	...	55	24	(5)	11.0	11.0	11.0	11.0	11.0	8.0	3.8	...	...
SB-98	C65100	Rods	Soft Anneal/060	33	...	40	12	(5)	8.0	7.9	7.9	7.9	7.9	5.0	3.7	...	...
SB-98	C65100	Rods	Half Hard/H02	33	...	55	20	(5)	11.0	11.0	11.0	11.0	11.0	8.0	3.8	...	...
SB-315	C65500	Pipe & Tube	Annealed/030/061	33	NFC-2	50	15	(5)	10.0	10.0	9.9	9.8	9.7	5.0	3.7	...	...
Red-Brass																	
SB-43	C23000	Smls. Pipe	Annealed/061	32	NFC-2	40	12	...	8.0	8.0	8.0	8.0	8.0	7.0	4.8	...	...
SB-111	C23000	Smls. Condenser Tubes	Annealed/061	32	NFC-2	40	12	...	8.0	8.0	8.0	8.0	8.0	7.0	4.8	...	...
SB-395	C23000	Smls. Condenser Tubes	Annealed/061	32	NFC-2	40	12	...	8.0	8.0	8.0	8.0	8.0	7.0	4.8	...	...
Admirality																	
SB-395	C44300	Smls. Condenser Tubes	Annealed/061	32	NFC-2	45	15	...	9.0	9.0	9.0	9.0	9.0	9.0	3.5	...	...
SB-395	C44400	Smls. Condenser Tubes	Annealed/061	32	NFC-2	45	15	...	9.0	9.0	9.0	9.0	9.0	9.0	3.5	...	...
SB-395	C44500	Smls. Condenser Tubes	Annealed/061	32	NFC-2	45	15	...	9.0	9.0	9.0	9.0	9.0	9.0	3.5	...	...
SB-171	C44300	Plates, ≤ 4 in.	...	32	NFC-2	45	15	...	9.0	9.0	9.0	9.0	9.0	9.0	3.5	...	...
SB-171	C44400	Plates, ≤ 4 in.	...	32	NFC-2	45	15	...	9.0	9.0	9.0	9.0	9.0	9.0	3.5	...	...
SB-171	C44500	Plates, ≤ 4 in.	...	32	NFC-2	45	15	...	9.0	9.0	9.0	9.0	9.0	9.0	3.5	...	...
Naval Brass																	
SB-171	C46400	Plates, ≤ 3 in.	...	32	NFC-2	50	20	...	10.0	10.0	10.0	10.0	10.0	6.3	2.5	...	...
Copper-Nickel																	
SB-111	C70600	Smls. Condenser Tubes	Annealed/061	34	NFC-3	40	15	...	8.0	8.0	7.9	7.6	7.3	7.1	6.9	6.7	6.6
SB-111	C71000	Smls. Condenser Tubes	Annealed/061	34	NFC-3	45	16	...	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
SB-111	C71500	Smls. Condenser Tubes	Annealed/061	34	NFC-4	52	18	...	10.4	10.4	10.4	10.4	10.4	10.4	10.3	10.1	9.9
SB-171	C70600	Plates, ≤ 5 in.	...	34	NFC-3	40	15	...	8.0	8.0	7.9	7.6	7.3	7.1	6.9	6.7	6.6
SB-171	C71500	Plates, ≤ $2\frac{1}{2}$ in.	...	34	NFC-4	50	20	...	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
SB-395	C70600	Smls. Condenser Tubes	Annealed/061	34	NFC-3	40	15	...	8.0	8.0	7.9	7.6	7.3	7.1	6.9	6.7	6.6
SB-395	C71000	Smls. Condenser Tubes	Annealed/061	34	NFC-3	45	16	...	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
SB-395	C71500	Smls. Condenser Tubes	Annealed/061	34	NFC-4	52	18	...	10.4	10.4	10.4	10.4	10.4	10.4	10.3	10.1	9.9
SB-466	C70600	Pipe & Tube	Annealed	34	NFC-3	38	13	...	7.6	7.6	7.5	7.2	6.9	6.7	6.5	6.4	6.3
SB-466	C71000	Pipe & Tube	Annealed	34	NFC-3	45	16	...	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
SB-466	C71500	Pipe & Tube	Annealed	34	NFC-4	52	18	...	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	9.9

A08

TABLE HF-300.2
MAXIMUM ALLOWABLE STRESS VALUES FOR NONFERROUS MATERIALS, ksi (CONT'D)
(multiply by 1000 to obtain psi)

Spec. No.	Alloy Designation UNS No.	Product Form	Class/Condition/Temper	P-No.	External Pressure Chart	Spec. Min. Tensile Strength, ksi	Spec. Min. Yield Strength, ksi	Note(s)	Maximum Allowable Stress Value, ksi								
									Up To 100°F	150	200	250	300	350	400	450	500
Nickel-Copper																	
SB-164	N04400	Bar	Hot or Cold Worked, Annealed	42	NFN-3	70	25	(6)	14.0	14.0	14.0	14.0	13.6	13.3	13.2	13.1	13.1
SB-164	N04400	Rounds	Hot Worked (As Worked or Stress Relieved)	42	NFN-3	80	40	(6)	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0	16.0
SB-165	N04400	Smls. Pipe & Tube, 5 in. O.D. max.	Annealed	42	NFN-3	70	28	(6)	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0	14.0
SB-165	N04400	Smls. Pipe & Tube, Over 5 in. O.D.	Annealed	42	NFN-3	70	25	(6)	14.0	14.0	14.0	14.0	13.6	13.3	13.2	13.1	13.1
SB-165	N04400	Smls. Pipe & Tube, All Sizes	Stress Relieved	42	NFN-3	85	55	(6)	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0
Integrally Finned Tubes																	
SB-359	...	...	...	...	...	...	...	(7)	...	...	...	...	...	...	...	...	...
Casting, Bronze and Brass																	
SB-61	C92200	Steam or Valve Bronze	...	...	NFN-1	34	16	(8)	5.4	5.4	5.4	5.4	5.4	5.4	4.7	...	...
SB-62	C83600	85-5-5-5 Composition Brass	...	...	NFC-1	30	14	(8)	6.0	6.0	6.0	6.0	6.0	5.8	5.7	5.6	5.5
SB-584	C84400	81-3-7-9 Composition Semi-red Brass	...	...	...	29	13	(8)	4.6	4.6	4.6	4.5	4.3	4.1	4.0	...	...
SB-584	C90300	88-8-0-9 Tin Bronze	...	...	...	40	18	(8)	5.1	5.1	5.1	5.1	5.1	5.1	5.1	...	...
Casting, Bronze, Brass, and Aluminum																	
SB/EN 1706 EN AC4300	AlSi10Mg(a)	Castings	F	...	...	21.8	11.6	(8)(9)	4.6	4.4	4.4	4.3	4.3	3.9	...	...	...
Nickel-Chromium-Tungsten																	
SB-366	N06230	Fittings	Sol. Annealed	43	NFN-24	110.0	45.0	...	22.0	22.0	22.0	22.0	22.0	21.9	21.5	21.2	21.0
SB-435	N06230	Plate, Sheet, Strip	Sol. Annealed	43	NFN-24	110.0	45.0	...	22.0	22.0	22.0	22.0	22.0	21.9	21.5	21.2	21.0
SB-572	N06230	Rod (bar)	Sol. Annealed	43	NFN-24	110.0	45.0	...	22.0	22.0	22.0	22.0	22.0	21.9	21.5	21.2	21.0
SB-564	N06230	Forgings	Sol. Annealed	43	NFN-24	110.0	45.0	...	22.0	22.0	22.0	22.0	22.0	21.9	21.5	21.2	21.0
SB-619	N06230	Welded Pipe	Sol. Annealed	43	NFN-24	110.0	45.0	...	18.7	18.7	18.7	18.7	18.7	18.6	18.3	18.0	17.9
SB-622	N06230	Seamless Pipe & Tube	Sol. Annealed	43	NFN-24	110.0	45.0	...	22.0	22.0	22.0	22.0	22.0	21.9	21.5	21.2	21.0
SB-626	N06230	Welded Tube	Sol. Annealed	43	NFN-24	110.0	45.0	...	18.7	18.7	18.7	18.7	18.7	18.6	18.3	18.0	17.9
Nickel-Iron-Chromium																	
SB-409	N08810	Plate	Sol. Annealed	45	NFN-9	65	25	(10)	13.0	13.0	13.0	13.0	13.0	13.0	12.9	12.8	12.8
SB-409	N08800	Plate	Annealed	45	NFN-8	75	30	(10)	15.0	...	...	...	...	...	...	...	...

A08

TABLE HF-300.2
MAXIMUM ALLOWABLE STRESS VALUES FOR NONFERROUS MATERIALS, ksi (CONT'D)
(multiply by 1000 to obtain psi)

NOTES:

(1) When material is to be welded, the phosphorous deoxidized types should be specified.

(2) When nonferrous materials conforming to specifications given in Section II are used in welded or brazed construction, the maximum allowable working stresses shall not exceed the values given herein for the material in the annealed condition.

(3) For use in HG-307.2(b) eq. (2), the maximum allowable stress at room temperature (100°F, max.) shall be 10.0 ksi (through $1\frac{1}{2}$ in. thickness) and 9.2 ksi (over $1\frac{1}{2}$ in. thickness).

(4) No welding or brazing permitted.

(5) Copper-silicon alloys are not always suitable when exposed to certain median and high temperatures, particularly steam above 212°F. Therefore this material is limited to the construction of hot water boilers to be operated at a temperature not to exceed 200°F.

(6) To be used for HLW connections only.

(7) Use in accordance with HF-204 and HF-204.1.

(8) The stress value includes a casting quality factor of 0.80. Increased casting quality factors as a result of material examination beyond the requirement of the material specification shall not be permitted. This is not intended to apply to valves and fittings made to recognized standards.

(9) The maximum water temperature shall not exceed 200°F.

(10) The maximum water temperature shall not exceed 210°F.

(11) For welded or brazed construction.

07
A08

TABLE HF-300.2M
MAXIMUM ALLOWABLE STRESS VALUES FOR NONFERROUS MATERIALS, MPa

Spec. No.	Alloy Designation UNS No.	Product Form	Class/Condition/Temper	P-No.	External Pressure Chart	Spec. Min. Tensile Strength, MPa	Spec. Min. Yield Strength, MPa	Note(s)	Maximum Allowable Stress Value, MPa								
									Up To 40°C	65	100	125	150	175	200	225	250
Aluminum																	
SB-209	A95052	Sheet and Plate	H32 wld.	22	NFA-8	172	69	...	34.5	34.5	34.5	34.5	32.8	...	...	...	...
SB-209	A96061	Sheet and Plate	T6 wld.	23	NFA-12	165	55	...	33.1	33.1	33.1	32.6	31.2	...	...	...	...
SB-209	A96061	Sheet and Plate	T651 wld.	23	NFA-12,13	165	55	...	33.1	33.1	33.1	32.6	31.2	...	...	...	...
SB-210	A93003	Drawn Seamless Tube	0	21	NFA-1	97	34	...	19.3	19.1	17.4	15.9	14.4	...	...	...	...
SB-210	A95052	Drawn Seamless Tube	H32 wld.	22	NFA-12	172	69	...	34.5	34.5	34.5	34.5	32.8	...	...	...	...
SB-210	A96061	Drawn Seamless Tube	T6	23	NFA-12,13	290	241	(4)	57.9	57.9	57.9	55.5	47.9	...	...	...	...
SB-210	A96061	Drawn Seamless Tube	T6	23	NFA-12,13	165	...	(11)	33.1	33.1	33.1	31.7	27.4	...	...	...	...
SB-210	A96061	Drawn Seamless Tube	T6 wld.	23	NFA-12,13	165	55	...	33.1	33.1	33.1	32.6	31.2	...	...	...	...
SB-211	A96061	Bar, Rod, Wire	T6 wld.	23	NFA-12	165	55	...	33.1	33.1	33.1	32.6	31.2	...	...	...	...
SB-211	A96061	Bar, Rod, Wire	T651 wld.	23	NFA-12,13	165	55	...	33.1	33.1	33.1	32.6	31.2	...	...	...	...
SB-221	A96061	Extrude Bar, Rod and Shapes	T6 wld.	23	NFA-12,13	165	55	...	33.1	33.1	33.1	32.6	31.2	...	...	...	...
SB-241	A95052	Seamless Pipe and Seamless Extruded Tube	H32 wld.	22	NFA-8	172	69	...	34.5	34.5	34.5	34.5	32.8	...	...	...	...
SB-241	A96061	Seamless Pipe and Seamless Extruded Tube	T6 wld.	23	NFA-12,13	165	55	...	33.1	33.1	33.1	32.6	31.2	...	...	...	...
Aluminum Bronze																	
SB-111	C60800	Smls. Condenser Tubes	Annealed/061	35	NFC-2	345	131	...	68.9	68.9	68.9	68.9	68.9	68.4	65.8	...	...
Copper																	
SB-42	C10200	Pipe	Annealed/061	31	NFC-1	205	62	(1)	41.4	35.0	33.4	32.9	32.3	27.8	21.7	...	...
SB-42	C10200	Pipe	Hard Drawn/H80 - $\frac{1}{8}$ in. to 2 in. NPS, incl.	31	NFC-4	310	275	(1)(2)	62.1	62.1	62.1	62.1	60.3	57.1	36.3	...	...
SB-42	C10200	Pipe	Light Drawn/H55 - $2\frac{1}{2}$ in. to 12 in. NPS, incl.	31	NFC-3	250	205	(1)(2)	49.6	49.6	49.6	49.6	48.1	46.9	45.7	...	...
SB-42	C12000	Pipe	Annealed/061	31	NFC-1	205	62	(1)	41.4	35.0	33.4	32.9	32.3	27.8	21.7	...	...
SB-42	C12000	Pipe	Hard Drawn/H80 - $\frac{1}{8}$ in. to 2 in. NPS, incl.	31	NFC-4	310	275	(1)(2)	62.1	62.1	62.1	62.1	60.3	57.1	36.3	...	...
SB-42	C12000	Pipe	Light Drawn/H55 - $2\frac{1}{2}$ in. to 12 in. NPS, incl.	31	NFC-3	250	205	(1)(2)	49.6	49.6	49.6	49.6	48.1	46.9	45.7	...	...
SB-42	C12200	Pipe	Annealed/061	31	NFC-1	205	62	(1)	41.4	35.0	33.4	32.9	32.3	27.8	21.7	...	...
SB-42	C12200	Pipe	Hard Drawn/H80 - $\frac{1}{8}$ in. to 2 in. NPS, incl.	31	NFC-4	310	275	(1)(2)	62.1	62.1	62.1	62.1	60.3	57.1	36.3	...	...
SB-42	C12200	Pipe	Light Drawn/H55 - $2\frac{1}{2}$ in. to 12 in. NPS, incl.	31	NFC-3	250	205	(1)(2)	49.6	49.6	49.6	49.6	48.1	46.9	45.7	...	...

TABLE HF-300.2M
MAXIMUM ALLOWABLE STRESS VALUES FOR NONFERROUS MATERIALS, MPa (CONT'D)

Spec. No.	Alloy Designation UNS No.	Product Form	Class/Condition/Temper	P-No.	External Pressure Chart	Spec. Min. Tensile Strength, MPa	Spec. Min. Yield Strength, MPa	Note(s)	Maximum Allowable Stress Value, MPa Up To 40°C	65	100	125	150	175	200	225	250
Copper (Cont'd)																	
SB-75	C10200	Smls. Tubes	Annealed/050/060	31	NFC-1	205	62	(1)	41.4	35.0	33.4	32.9	32.3	27.8	21.7	...	...
SB-75	C10200	Smls. Tubes	Light Drawn/H55	31	NFC-3	250	205	(1)(2)	49.6	49.6	49.6	49.6	48.1	46.9	45.7	...	...
SB-75	C10200	Smls. Tubes	Hard Drawn/H80	31	NFC-4	310	275	(1)(2)	62.1	62.1	62.1	62.1	60.3	57.1	36.3	...	...
SB-75	C12000	Smls. Tubes	Annealed/050/060	31	NFC-1	205	62	(1)	41.4	35.0	33.4	32.9	32.3	27.8	21.7	...	...
SB-75	C12000	Smls. Tubes	Light Drawn/H55	31	NFC-3	250	205	(1)(2)	49.6	49.6	49.6	49.6	48.1	46.9	45.7	...	...
SB-75	C12000	Smls. Tubes	Hard Drawn/H80	31	NFC-4	310	275	(1)(2)	62.1	62.1	62.1	62.1	60.3	57.1	36.3	...	...
SB-75	C12200	Smls. Tubes	Annealed/050/060	31	NFC-1	205	62	(1)	41.4	35.0	33.4	32.9	32.3	27.8	21.7	...	...
SB-75	C12200	Smls. Tubes	Light Drawn/H55	31	NFC-3	250	205	(1)(2)	49.6	49.6	49.6	49.6	48.1	46.9	45.7	...	...
SB-75	C12200	Smls. Tubes	Hard Drawn/H80	31	NFC-4	310	275	(1)(2)	62.1	62.1	62.1	62.1	60.3	57.1	36.3	...	...
SB-111	C10200	Smls. Condenser Tubes	Light Drawn/H55	31	NFC-6	250	205	(1)	49.6	49.6	49.6	49.6	48.1	46.9	45.7	...	...
SB-111	C10200	Smls. Condenser Tubes	Hard Drawn/H80	31	NFC-4	310	275	(1)	62.1	62.1	62.1	62.1	60.3	57.1	36.3	...	...
SB-111	C12000	Smls. Condenser Tubes	Light Drawn/H55	31	NFC-6	250	205	(1)	49.6	49.6	49.6	49.6	48.1	46.9	45.7	...	...
SB-111	C12000	Smls. Condenser Tubes	Hard Drawn/H80	31	NFC-4	310	275	(1)	62.1	62.1	62.1	62.1	60.3	57.1	36.3	...	...
SB-111	C12200	Smls. Condenser Tubes	Light Drawn/H55	31	NFC-6	250	205	(1)	49.6	49.6	49.6	49.6	48.1	46.9	45.7	...	...
SB-111	C12200	Smls. Condenser Tubes	Hard Drawn/H80	31	NFC-4	310	275	(1)	62.1	62.1	62.1	62.1	60.3	57.1	36.3	...	...
SB-111	C14200	Smls. Condenser Tubes	Light Drawn/H55	31	NFC-6	250	205	(1)	49.6	49.6	49.6	49.6	48.1	46.9	45.7	...	...
SB-111	C14200	Smls. Condenser Tubes	Hard Drawn/H80	31	NFC-4	310	275	(1)	62.1	62.1	62.1	62.1	60.3	57.1	36.3	...	...
SB-152	C10200	Plate, Sheet, Strip, & Bar	Hot Rolled/025, Annealed	31	NFC-1	205	70	(1)	41.4	38.9	37.1	35.7	34.1	27.8	21.7	...	...
SB-152	C10400	Plate, Sheet, Strip	Hot Rolled/025, Annealed	31	NFC-1	205	70	(1)	41.4	38.9	37.1	35.7	34.1	27.8	21.7	...	...
SB-152	C10500	Plate, Sheet, Strip	Hot Rolled/025, Annealed	31	NFC-1	205	70	(1)	41.4	38.9	37.1	35.7	34.1	27.8	21.7	...	...
SB-152	C10700	Plate, Sheet, Strip	Hot Rolled/025, Annealed	31	NFC-1	205	70	(1)	41.4	38.9	37.1	35.7	34.1	27.8	21.7	...	...
SB-152	C11000	Plate, Sheet, Strip, & Bar	Hot Rolled/025, Annealed	31	NFC-1	205	70	(1)	41.4	38.9	37.1	35.7	34.1	27.8	21.7	...	...
SB-152	C12200	Plate, Sheet, Strip	Hot Rolled/025, Annealed	31	NFC-1	205	70	(1)	41.4	38.9	37.1	35.7	34.1	27.8	21.7	...	...
SB-152	C12300	Plate, Sheet, Strip, & Bar	Hot Rolled/025, Annealed	31	NFC-1	205	70	(1)	41.4	38.9	37.1	35.7	34.1	27.8	21.7	...	...
SB-152	C14200	Plate, Sheet, Strip	Hot Rolled/025, Annealed	31	NFC-1	205	70	(1)	41.4	38.9	37.1	35.7	34.1	...	...	...	...
SB-283	C37700	Forging Brass	As Forged/M10/M11	...	...	315	105	(3)(4)	63.4	63.4	61.3	...	...	...	...	...	...
SB-395	C10200	Smls. Tubes	Light Drawn/H55	31	NFC-6	250	205	(1)(2)	49.6	49.6	49.6	49.6	48.1	46.9	45.7	...	...
SB-395	C12000	Smls. Tubes	Light Drawn/H55	31	NFC-6	250	205	(1)(2)	49.6	49.6	49.6	49.6	48.1	46.9	45.7	...	...
SB-395	C12200	Smls. Tubes	Light Drawn/H55	31	NFC-6	250	205	(1)(2)	49.6	49.6	49.6	49.6	48.1	46.9	45.7	...	...
SB-395	C14200	Smls. Tubes	Light Drawn/H55	31	NFC-6	250	205	(1)(2)	49.6	49.6	49.6	49.6	48.1	46.9	45.7	...	...

TABLE HF-300.2M
MAXIMUM ALLOWABLE STRESS VALUES FOR NONFERROUS MATERIALS, MPa (CONT'D)

Spec. No.	Alloy Designation UNS No.	Product Form	Class/Condition/Temper	P-No.	External Pressure Chart	Spec. Min. Tensile Strength, MPa	Spec. Min. Yield Strength, MPa	Note(s)	Maximum Allowable Stress Value, MPa								
									Up To 40°C	65	100	125	150	175	200	225	250
Copper-Silicon																	
SB-96	C65500	Plate & Sheet	Annealed/061	33	NFC-2	345	125	(5)	68.9	68.9	68.9	68.9	68.9	35.3	27.1	...	...
SB-98	C65500	Rods	Soft Anneal/060	33	...	360	105	(5)	68.9	68.6	68.0	67.4	66.7	35.3	27.1	...	...
SB-98	C65500	Rods	Quarter Hard/H01	33	...	380	165	(5)	75.8	75.8	75.8	75.8	75.8	58.4	29.2	...	...
SB-98	C65100	Rods	Soft Anneal/060	33	...	275	83	(5)	55.2	54.3	54.3	54.3	54.1	35.3	27.1	...	...
SB-98	C65100	Rods	Half Hard/H02	33	...	380	140	(5)	75.8	75.8	75.8	75.8	75.8	58.4	29.2	...	...
SB-315	C65500	Pipe & Tube	Annealed/030/061	33	NFC-2	345	105	(5)	68.9	68.6	68.0	67.4	66.7	35.3	27.1	...	...
Red Brass																	
SB-43	C23000	Smls. Pipe	Annealed/061	32	NFC-2	275	83	...	55.2	55.1	55.1	55.1	55.1	50.0	36.3	...	...
SB-111	C23000	Smls. Condenser Tubes	Annealed/061	32	NFC-2	275	83	...	55.2	55.1	55.1	55.1	55.1	50.0	36.3	...	...
SB-395	C23000	Smls. Condenser Tubes	Annealed/061	32	NFC-2	275	83	...	55.2	55.1	55.1	55.1	55.1	50.0	36.3	...	...
Admirality																	
SB-395	C44300	Smls. Condenser Tubes	Annealed/061	32	NFC-2	310	105	...	62.1	62.1	62.1	62.1	62.1	62.1	27.7	...	...
SB-395	C44400	Smls. Condenser Tubes	Annealed/061	32	NFC-2	310	105	...	62.1	62.1	62.1	62.1	62.1	62.1	27.7	...	...
SB-395	C44500	Smls. Condenser Tubes	Annealed/061	32	NFC-2	310	105	...	62.1	62.1	62.1	62.1	62.1	62.1	27.7	...	...
SB-171	C44300	Plates, ≤ 100 mm	...	32	NFC-2	310	105	...	62.1	62.1	62.1	62.1	62.1	62.1	27.7	...	...
SB-171	C44400	Plates, ≤ 100 mm	...	32	NFC-2	310	105	...	62.1	62.1	62.1	62.1	62.1	62.1	27.7	...	...
SB-171	C44500	Plates, ≤ 100 mm	...	32	NFC-2	310	105	...	62.1	62.1	62.1	62.1	62.1	62.1	27.7	...	...
Naval Brass																	
SB-171	C46400	Plates, ≤ 75 mm	...	32	NFC-2	345	140	...	68.9	68.9	68.9	68.9	68.9	45.4	19.9	...	...
Copper-Nickel																	
SB-111	C70600	Smls. Condenser Tubes	Annealed/061	34	NFC-3	275	105	...	55.2	55.2	54.0	52.1	50.3	48.8	47.5	46.5	45.7
SB-111	C71000	Smls. Condenser Tubes	Annealed/061	34	NFC-3	310	110	...	62.1	62.1	62.1	62.1	62.1	62.1	62.1	62.1	62.1
SB-111	C71500	Smls. Condenser Tubes	Annealed/061	34	NFC-4	360	125	...	71.7	71.7	71.7	71.7	71.7	71.7	71.4	70.1	68.9
SB-171	C70600	Plates, ≤ 125 mm	...	34	NFC-3	275	105	...	55.2	55.2	54.0	52.1	50.3	48.8	47.5	46.5	45.7
SB-171	C71500	Plates, ≤ 64 mm	...	34	NFC-4	360	140	...	68.9	68.9	68.9	68.9	68.9	68.9	68.9	68.9	68.9
SB-395	C70600	Smls. Condenser Tubes	Annealed/061	34	NFC-3	275	105	...	55.2	55.2	54.0	52.1	50.3	48.8	47.5	46.5	45.7
SB-395	C71000	Smls. Condenser Tubes	Annealed/061	34	NFC-3	310	110	...	62.1	62.1	62.1	62.1	62.1	62.1	62.1	62.1	62.1
SB-395	C71500	Smls. Condenser Tubes	Annealed/061	34	NFC-4	360	125	...	71.7	71.7	71.7	71.7	71.7	71.7	71.4	70.1	68.9
SB-466	C70600	Pipe & Tube	Annealed	34	NFC-3	260	90	...	52.4	52.4	51.3	49.5	47.8	46.3	45.1	44.2	43.5
SB-466	C71000	Pipe & Tube	Annealed	34	NFC-3	310	110	...	62.1	62.1	62.1	62.1	62.1	62.1	62.1	62.1	62.1
SB-466	C71500	Pipe & Tube	Annealed	34	NFC-4	345	125	...	68.9	68.9	68.9	68.9	68.9	68.9	68.9	68.9	68.9

A08

TABLE HF-300.2M
MAXIMUM ALLOWABLE STRESS VALUES FOR NONFERROUS MATERIALS, MPa (CONT'D)

Spec. No.	Alloy Designation UNS No.	Product Form	Class/Condition/Temper	P-No.	External Pressure Chart	Spec. Min. Tensile Strength, MPa	Spec. Min. Yield Strength, MPa	Note(s)	Maximum Allowable Stress Value, MPa								
									Up To 40°C	65	100	125	150	175	200	225	250
Nickel-Copper																	
SB-164	N04400	Bar	Hot or Cold Worked, Annealed	42	NFN-3	485	170	(6)	96.5	96.5	96.5	96.2	93.6	91.9	90.9	90.4	90.4
SB-164	N04400	Rounds	Hot Worked (As Worked or Stress Relieved)	42	NFN-3	550	275	(6)	110	110	110	110	110	110	110	110	110
SB-165	N04400	Smls. Pipe & Tube, 125 mm O.D. max.	Annealed	42	NFN-3	485	195	(6)	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5
SB-165	N04400	Smls. Pipe & Tube, Over 125 mm O.D.	Annealed	42	NFN-3	485	170	(6)	96.5	96.5	96.5	96.2	93.6	91.9	90.9	90.4	90.4
SB-165	N04400	Smls. Pipe & Tube, All sizes	Stress Relieved	42	NFN-3	585	380	(6)	117	117	117	117	117	117	117	117	117
Integrally Finned Tubes																	
SB-359	...	...	...	...	...	...	...	(7)	...	...	...	...	...	...	...	...	...
Casting, Bronze and Brass																	
SB-61	C92200	Steam or Valve Bronze	...	...	NFN-1	235	110	(8)	37.5	37.5	37.5	37.5	37.5	37.5	33.4	...	...
SB-62	C83600	85-5-5-5 Composition Brass	...	...	NFC-1	205	97	(8)	41.4	41.4	41.4	41.4	41.3	40.2	39.2	...	...
SB-584	C84400	81-3-7-9 Composition Semi-red Brass	...	...	...	200	90	(8)	32.0	32.0	31.9	30.6	29.3	28.3	27.7	...	...
SB-584	C90300	88-8-0-9 Tin Bronze	...	...	...	275	125	(8)	35.3	35.3	35.3	35.3	35.3	35.3	35.3	...	...
Casting, Bronze, Brass, and Aluminum																	
SB/EN 1706 EN AC4300	AlSi10Mg(a)	Castings	F	...	...	150.0	80.6	(8)(9)	24.0	24.0	24.0	24.0	24.0	...	...	...	...
Nickel-Chromium-Tungsten																	
SB-366	N06230	Fittings	Sol. Annealed	43	NFN-24	758	310	...	152.0	152.0	152.0	152.0	152.0	151.0	149.0	147.0	145.0
SB-435	N06230	Plate, Sheet, Strip	Sol. Annealed	43	NFN-24	758	310	...	152.0	152.0	152.0	152.0	152.0	151.0	149.0	147.0	145.0
SB-572	N06230	Rod (bar)	Sol. Annealed	43	NFN-24	758	310	...	152.0	152.0	152.0	152.0	152.0	151.0	149.0	147.0	145.0
SB-564	N06230	Forgings	Sol. Annealed	43	NFN-24	758	310	...	152.0	152.0	152.0	152.0	152.0	151.0	149.0	147.0	145.0
SB-619	N06230	Welded Pipe	Sol. Annealed	43	NFN-24	758	310	...	129.2	129.2	129.2	129.2	129.2	128.4	126.7	125.0	123.3
SB-622	N06230	Seamless Pipe & Tube	Sol. Annealed	43	NFN-24	758	310	...	152.0	152.0	152.0	152.0	152.0	151.0	149.0	147.0	145.0
SB-626	N06230	Welded Tube	Sol. Annealed	43	NFN-24	758	310	...	129.2	129.2	129.2	129.2	129.2	128.4	126.7	125.0	123.3

A08

TABLE HF-300.2M
MAXIMUM ALLOWABLE STRESS VALUES FOR NONFERROUS MATERIALS, MPa (CONT'D)

Spec. No.	Alloy Designation UNS No.	Product Form	Class/Condition/Temper	P-No.	External Pressure Chart	Spec. Min. Tensile Strength, MPa	Spec. Min. Yield Strength, MPa	Note(s)	Maximum Allowable Stress Value, MPa								
									Up To 40°C	65	100	125	150	175	200	225	250
Nickel-Iron-Chromium																	
SB-409	N08810	Plate	Sol. Annealed	45	NFN-9	450	170	(10)	89.6	89.6	89.6	89.6	89.6	89.6	89.2	88.7	88.3
SB-409	N08800	Plate	Annealed	45	NFN-8	520	210	(10)	103	...	...	...	...	...	...	...	...

NOTES:

(1) When material is to be welded, the phosphorous deoxidized types should be specified.

(2) When nonferrous materials conforming to specifications given in Section II are used in welded or brazed construction, the maximum allowable working stresses shall not exceed the values given herein for the material in the annealed condition.

(3) For use in HG-307.2(b) eq.(2), the maximum allowable stress at room temperature (40°C, max.) shall be 68.9 MPa (through 38 mm thickness) and 63.4 MPa (over 38 mm thickness).

(4) No welding or brazing permitted.

(5) Copper-silicon alloys are not always suitable when exposed to certain median and high temperatures, particularly steam above 100°C. Therefore this material is limited to the construction of hot water boilers to be operated at a temperature not to exceed 93°C.

(6) To be used for HLW connections only.

(7) Use in accordance with HF-204 and HF-204.1.

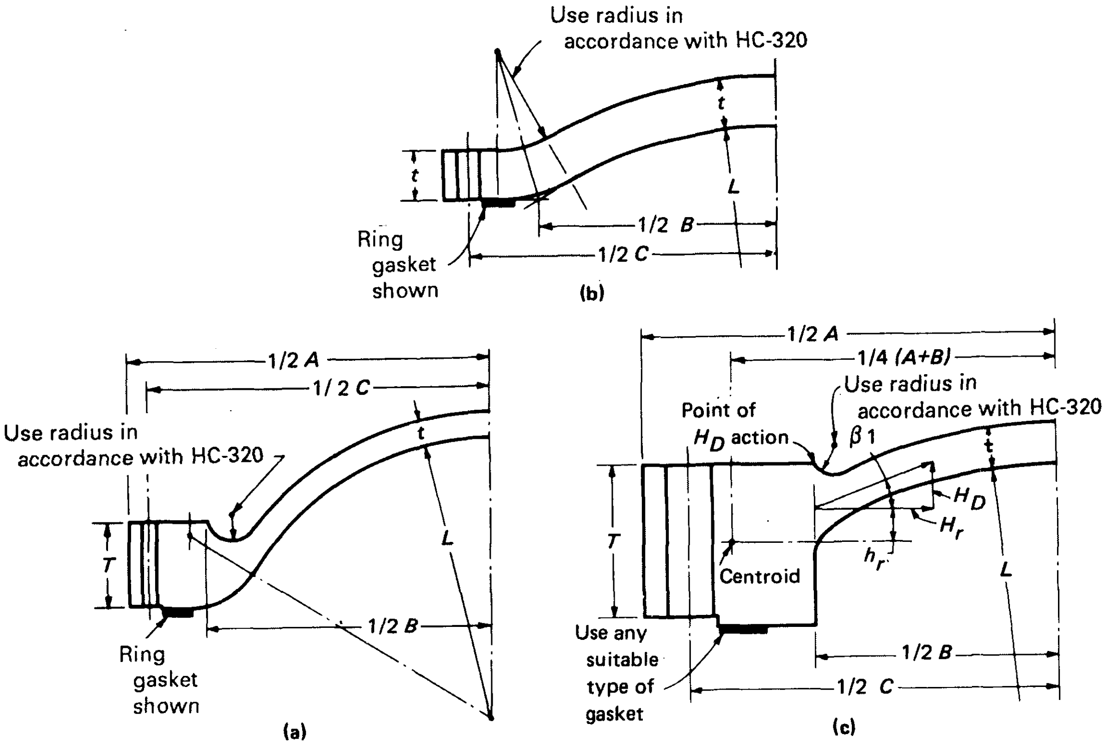
(8) The stress value includes a casting quality factor of 0.80. Increased casting quality factors as a result of material examination beyond the requirement of the material specification shall not be permitted. This is not intended to apply to valves and fittings made to recognized standards.

(9) The maximum water temperature shall not exceed 93°C.

(10) The maximum water temperature shall not exceed 96°C.

(11) For welded or brazed construction.

FIG. HC-311 SPHERICALLY SHAPED COVERS WITH BOLTING FLANGES



M_o = the total moment determined as in Section VIII, Division 1, Appendix 2, 2-6, except that for heads of the type shown in Fig. HC-311, sketch (c), a moment $H_r h_r$ (which may add or subtract) shall be included in addition to the moment $H_D h_D$ where

H_D = axial component of the membrane load in the spherical segment acting at the inside of the flange ring
= $0.785B^2P$

h_D = radial distance from the bolt circle to the inside of the flange ring

H_r = radial component of the membrane load in the spherical segment acting at the intersection of the inside of the flange ring with the center line of the dished cover thickness
= $H_D \cot \beta_1$

h_r = lever arm of force H_r about centroid of flange ring

P = design pressure for existing vessels

r = inside knuckle radius

S = maximum allowable stress value as given in Table HC-300

T = flange thickness

t = minimum required thickness of head plate after forming

β_1 = angle formed by the tangent to the center line of the dished cover thickness at its point of intersection with the flange ring, and a line perpendicular to the axis of the dished cover
= $\arcsin\,[B/(2L + t)]$

NOTE: Since $H_r h_r$ in some cases will subtract from the total moment, the moment in the flange ring when the internal pressure is zero may be the determining loading for the flange design.

HC-311.1 Heads Concave to Pressure. Circular spherically dished heads with bolting flanges, concave to the pressure and conforming to the several types illustrated in Fig. HC-311, shall be designed in accordance with the following formulas:

(a) Heads of the Type Shown in Fig. HC-311, Sketch (a)

(1) Head thickness

$$t = \frac{5PL}{6S}$$

(2) Flange thickness T:

For ring gasket,

$$T = \sqrt{\frac{M_o}{SB}\left[\frac{A + B}{A - B}\right]}$$

For full-faced gasket,

$$T = 0.6\sqrt{\frac{P}{S}\left[\frac{B(A+B)(C-B)}{A-B}\right]}$$

NOTE: The radial components of the membrane load in the spherical segment are assumed to be resisted by its flange.

Within the range of ANSI B16.1-1975, the flange facings and drillings should conform to those standards and the thickness specified therein shall be considered as a minimum requirement.

(b) Heads of the Type Shown in Fig. HC-311, Sketch (b)

(1) Head thickness

$$t = \frac{5PL}{6S}$$

(2) Flange thickness for ring gaskets shall be calculated as follows:

A08 *(a)* For heads with round bolting holes,

$$T = Q + \sqrt{\frac{1.875M_o(C+B)}{SB(7C-5B)}} \qquad \text{(I)}$$

$$Q = \frac{PL}{4S}\left[\frac{C+B}{7C-5B}\right] \qquad \text{(II)}$$

(b) For heads with bolting holes slotted through the edge of the head,

$$T = Q + \sqrt{\frac{1.875M_o(C+B)}{SB(3C-B)}} \qquad \text{(III)}$$

$$Q = \frac{PL}{4S}\left[\frac{C+B}{3C-B}\right] \qquad \text{(IV)}$$

(3) Flange thickness for full face gaskets shall be calculated by the following formula:

$$T = Q + \sqrt{Q^2 + \frac{3BQ(C-B)}{L}} \qquad \text{(V)}$$

The value of Q in eq. (V) is calculated by eq. (II) for round bolting holes or by eq. (IV) for bolting holes slotted through the edge of the head.

(4) The required flange thickness shall be T as calculated in (2) or (3) above, but in no case less than the value of t calculated in (1).

(c) Heads of the Type Shown in Fig. HC-311, Sketch (c)

(1) Head thickness

$$t = \frac{5PL}{6S}$$

(2) Flange thickness

$$T = F + \sqrt{F^2 + J}$$

where

$$F = \frac{PB\sqrt{4L^2 - B^2}}{8S\,(A-B)}$$

and

$$J = \left(\frac{M_o}{SB}\right)\left(\frac{A+B}{A-B}\right)$$

HC-315 OPENINGS AND REINFORCEMENTS

(a) The dimensional requirements in HG-320 through HG-328 are applicable to cast iron and shall be used in the design of openings and reinforcements in boilers and boiler parts.

(b) Cast iron flanges, nozzles, and opening reinforcements that enter into the design calculations of the completed boiler or boiler part, shall be cast integrally with the boiler or boiler part.

HC-320 CORNERS AND FILLETS 07

(a) A liberal radius shall be provided at projecting edges, reentrant corners, and the juncture of non–load-bearing heat-transmitting fins and pins where they connect to the body of the casting, in accordance with good foundry practice. Abrupt changes in surface contour and in wall thickness at junctures shall be avoided.

(b) Fillets and transition sections between adjacent main pressure containment walls or integral attachments thereto, such as nozzles, lugs, supports, flanges, and bosses, shall have radii or the equivalent not less than one times the thickness of the thinner of the sections being joined.

HC-325 WASHOUT OPENINGS

All cast iron steam and hot water boilers shall be provided with washout openings to permit the removal of any sediment that may accumulate therein. Washout plugs shall not be smaller than NPS 1½ (DN 40) for boilers having gross internal volume more than 5 ft^3 (142 l). Washout plugs shall not be smaller than 1 in. (25 mm) for boilers having gross internal volume not more than 5 ft^3 (142 l). Washout openings may be used for return pipe connections and the washout plug placed in a tee so that the plug is directly opposite and as close as possible to the opening in the boiler.

HC-330 ASSEMBLY METHOD

Cast iron boilers may be assembled using internal connections, such as electrochemically compatible metallic push nipples or grommet seals, or external connections such as cast iron headers or threaded pipe headers. The completed boiler shall satisfactorily pass the hydrostatic test prescribed in HC-410.

ARTICLE 2
MATERIAL REQUIREMENTS

HA-200 GENERAL MATERIAL REQUIREMENTS

(a) All materials used for cast sections of heating boilers that are constructed primarily of cast aluminum shall meet the requirements of this Article and material specifications listed in HF-300.2 for aluminum castings.

(b) External appurtenances such as cast or welded headers and other miscellaneous pressure parts shall be manufactured from materials permitted under Part HF-203. The design pressure for these pressure parts for which the strength cannot be computed shall be established in accordance with HG-500.

(c) Maximum allowable water temperature is 250°F (120°C).

HA-201 WORKMANSHIP, FINISH, AND REPAIR

(a) The surface of the casting shall conform substantially to the dimensions on drawings or to the dimensions predicated by the pattern, and be free from injurious defects. The surface of the casting shall be free from burnt-on sand and shall be reasonably smooth. Risers, fins, and projections used to facilitate the making of the casting shall be removed. In other respects, they shall conform to whatever requirements may be specially agreed upon between the Manufacturer and shop assembler when the shop assembler is separate from the Manufacturer.

(b) Seepage about chaplets, and minor leakage defects, may be repaired by plugging, impregnation, or welding as directed in the following:

(1) Provided the surrounding metal is sound, a minor leak may be plugged with a solid aluminum, brass, or stainless steel tapered thread pipe plug. The maximum size of the pipe plug shall be NPS 1 (DN 25) and there shall be no less than four full standard pipe threads in the section metal. (See Table HC-213.)

(2) Impregnation may be used to correct seepage leaks in aluminum alloy castings under the following conditions:

(a) Limitations of the extent and frequency of impregnation shall be as approved in the Manufacturer's written quality control system.

(b) Impregnated castings shall be marked in a way that is approved in the Manufacturer's written quality control system. The method of marking shall be documented in the shop assembler's QC manual when the shop assembler is separate from the Manufacturer.

(c) Control of the impregnation process shall be addressed in the Manufacturer's QC manual.

(d) The impregnation material shall meet the requirements of Class 1 material as defined in MIL-I-17563C.[1]

(e) Impregnation shall be accomplished in accordance with MIL-STD-276.[1]

(f) Welding shall not be performed on castings after impregnation.

(g) The Manufacturer shall hydrostatically test each casting per HA-406 after impregnation. **A08**

(3) Castings may be repaired by welding only as approved in the Manufacturer's and shop assemblers written quality control system.

(a) Limitations on the extent and frequency of such repairs, and methods of inspection of repaired areas shall also be covered in the written quality control system.

(b) The welding procedure and welders shall be qualified in accordance with Section IX.

(c) Control of the welding process shall be addressed in the quality control manual.

(d) Welding shall not be performed after impregnation.

HA-202 EXAMINATIONS AND TESTS

The Manufacturer shall be responsible for all examinations and tests. When requested by a shop assembler, the Manufacturer shall agree to permit a representative of the shop assembler to have entry, at the time while work under the contract of the shop assembler is being performed, to all parts of the Manufacturer's works that concern the castings manufactured to the requirements of this Article. All examinations and tests shall be made at the place of manufacture prior to shipment, unless otherwise specified and shall be so conducted as not to interfere unnecessarily with the operation of the works.

---

[1] Military specification is available from Standardization Documents Order Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

HA-203 TEST RECORDS

The Manufacturer shall record and retain all test results required by this Article for a period of at least 1 year. The test results shall be readily identifiable with the casting represented by the test results.

HA-502.7 Correction of Nonconformities. There shall be a system for correction of nonconformities. A nonconformity is any condition that does not comply with the applicable rules of this Section. Nonconformities must be corrected or eliminated before the completed component can be considered to comply with this Section.

HA-502.8 Calibration of Measurement and Test Equipment. The Manufacturer or shop assembler shall have a system for calibration of all equipment used for examination, measuring, and testing to fulfill the requirements of this Section.

HA-502.9 Sample Forms. The forms used in the quality control system and any detailed procedures for their use shall be available for review. The written description shall make necessary references to these forms. The forms exhibited shall be marked "Sample" and completed in a manner typical of actual production and test procedures.

HA-502.10 Retention of Records. The Manufacturer or shop assembler shall have a system for retaining the Manufacturer's Data Forms for a minimum of 15 years.

HA-502.11 ASME Designee

HA-502.11.1. The written description of the quality control system shall include reference to the ASME Designee.

HA-502.11.2. The Manufacturer or shop assembler shall make available to the ASME Designee a controlled copy of the written description of the quality control system.

HA-502.11.3. The Manufacturer's or shop assembler's quality control system shall provide for the ASME Designee to have access to all drawings, calculations, specifications, procedures, process sheets, repair procedures, records, test results, and any other documents as necessary for the ASME Designee to perform his review in accordance with this Section. The Manufacturer or shop assembler may provide such access either to his own files of such documents or by providing copies to the ASME designee.

HA-502.12 Certified Individual (CI). A Certified Individual shall provide oversight of the activities that affect the proper utilization of the "H" symbol on cast aluminum sections as outlined in Part HA.

HA-502.12.1 Requirements for a Certified Individual (CI). A Certified Individual shall

(a) be an employee of the Manufacturer

(b) be qualified by the Manufacturer. Qualifications shall include the following as a minimum:

(1) knowledge of the requirements of Parts HG, HC, and HA

(2) knowledge of the Manufacturer's quality control system

(3) training commensurate with the scope, complexity, or special nature of the activities to which oversight is provided

(c) have a record, maintained and certified by the Manufacturer, containing objective evidence of the qualifications and training of the CI

(d) not be directly involved in the production of cast aluminum sections for which he is performing the duties listed in HA-502.12.2

HA-502.12.2 Duties of a Certified Individual (CI). A08 A Certified Individual (CI) shall

(a) witness tests to determine the design pressure of boiler or boiler part as outlined in HA-403

(b) verify that cast aluminum sections marked with the "H" symbol shall have a current H-5A Manufacturer's Master Data Report for Boilers Constructed Primarily of Cast Aluminum

(c) review the tensile and chemical composition tests records, verifying that they meet the requirements of Table HF-300.2

(d) review documentation to verify that cast aluminum sections marked with the "H" symbol have been hydrostatically tested as required by HA-406

(e) sign the Certificates of Conformance as outlined in HA-504

HA-503 EXAMINATION A08

Examination of each boiler or part shall be in compliance with Article 2 of Part HA. Hydrostatic tests shall be conducted as required in HA-406 by the Manufacturer or shop assembler, and there shall be a means of identifying acceptable boiler sections or parts.

HA-504 CERTIFICATES OF CONFORMANCE

Cast aluminum boiler sections marked with the "H" symbol shall be recorded on Certificates of Conformance as follows:

(a) A Certificate of Conformance Form HA-1 listing the pattern number, cast date, and quantity of castings marked with the "H" symbol shall be filled out and signed by a representative of the Manufacturer and signed by a Certified Individual.

(1) Multiple cast aluminum boiler sections may be recorded on the same HA-1 form.

(2) Castings with the same casting date may be recorded on the same line.

A08 *(b)* A Certificate of Conformance Form HA-2 listing the pattern number, MAWP, hydrostatic test pressure, and quantity of cast aluminum sections that have satisfactorily passed the hydrostatic test required in HA-406 shall be filled out and signed by a representative of the Manufacturer, and signed by a Certified Individual. Multiple cast aluminum boiler sections may be recorded on the same HA-2 form.

(c) The Manufacturer's written quality control system shall include requirements for completion of the Certificates of Conformance and retention by the Manufacturer for a minimum of 5 years.

(d) The representative of the Manufacturer and Certified Individual above shall not be the same person.

ARTICLE 1
GENERAL

HLW-100 SCOPE

(a) The rules in Part HLW apply to water heaters and water storage tanks with corrosion resistance for supplying potable hot water. The foreword provides the basis for these rules. Part HLW is not intended to apply to hot water heating boilers.

(b) This Part contains mandatory requirements, specific prohibitions, and nonmandatory guidance for materials, designs, fabrication, examination, inspection, testing, certification, and pressure relief.

(c) Laws or regulations issued by a municipality, state, provincial, federal, or other enforcement or regulatory body having jurisdiction at the location of an installation, establish the mandatory applicability of these rules, in whole or in part.

HLW-101 SERVICE RESTRICTION AND EXCEPTION

HLW-101.1 Service Restriction. The rules of Part HLW are restricted to potable water heaters and water storage tanks for operation at pressures not exceeding 160 psi (1 100 kPa) and water temperatures not in excess of 210°F (99°C).

HLW-101.2 Exception. Based on the Committee's consideration, water heaters are exempted when none of the following limitations is exceeded:

(a) heat input of 200,000 Btu/hr (60 kW)

(b) water temperature of 210°F (99°C)

A08 *(c)* nominal water-containing capacity of 120 gal (450 l), except that they shall be equipped with safety devices in accordance with the requirements of HLW-700 and HLW-800

HLW-102 PERMISSIBLE STAMPING

Any water heater or storage tank that meets all of the requirements of Part HLW, including those for inspection, may be stamped with the Code HLW Symbol even though exempted from such stamping.

HLW-103 UNITS

Either U.S. Customary, SI, or any local customary units may be used to demonstrate compliance with all requirements of this edition (e.g., materials, design, fabrication, examination, inspection, testing, certification, and overpressure protection).

In general, it is expected that a single system of units shall be used for all aspects of design except where unfeasible or impractical. When components are manufactured at different locations where local customary units are different than those used for the general design, the local units may be used for the design and documentation of that component. Similarly, for proprietary components or those uniquely associated with a system of units different than that used for the general design, the alternate units may be used for the design and documentation of that component.

For any single equation, all variables shall be expressed in a single system of units. When separate equations are provided for U.S. Customary and SI units, those equations must be executed using variables in the units associated with the specific equation. Data expressed in other units shall be converted to U.S. Customary or SI units for use in these equations. The result obtained from execution of these equations may be converted to other units.

Production, measurement and test equipment, drawings, welding procedure specifications, welding procedure and performance qualifications, and other fabrication documents may be in U.S. Customary, SI, or local customary units in accordance with the fabricator's practice. When values shown in calculations and analysis, fabrication documents, or measurement and test equipment are in different units, any conversions necessary for verification of Code compliance and to ensure that dimensional consistency is maintained shall be in accordance with the following:

(a) Conversion factors shall be accurate to at least four significant figures.

(b) The results of conversions of units shall be expressed to a minimum of three significant figures.

Conversion of units, using the precision specified above shall be performed to assure that dimensional consistency is maintained. Conversion factors between U.S. Customary and SI units may be found in the Nonmandatory Appendix M, Guidance for the Use of U.S. Customary and SI Units in the ASME Boiler and Pressure Vessel Code. Whenever local customary units are used the Manufacturer shall provide the source of the conversion factors, which shall be subject to verification and acceptance by the Authorized Inspector or Certified Individual.

Material that has been manufactured and certified to either the U.S. Customary or SI material specification (e.g., SA-516M) may be used regardless of the unit system used in design. Standard fittings (e.g., flanges, elbows, etc.) that have been certified to either U.S. Customary units or SI units may be used regardless of the unit system used in design.

All entries on a Manufacturer's Data Report and data for Code required nameplate marking shall be in units consistent with the fabrication drawings for the component using U.S. Customary, SI, or local customary units. It is acceptable to show alternate units parenthetically. Users of this Code are cautioned that the receiving Jurisdiction should be contacted to ensure the units are acceptable.

TABLE HLW-300 07
MAXIMUM ALLOWABLE STRESS VALUES IN TENSION FOR LINED WATER HEATER MATERIALS, ksi (MPa) A08

Spec. No.	Grade	Nominal Composition	P-No.	Group No.	External Pressure Chart	Spec. Min. Tensile Strength, ksi (MPa)	Spec. Min. Yield Strength, ksi (MPa)	Note(s)	Max. Allow. Stress Value, ksi (MPa)
Plate									
SA-36	...	Carbon steel	1	1	...	58.0 (400)	...	(1)	14.5 (100.0)
SA-285	A	Carbon steel	1	1	...	45.0 (310)	...	...	11.3 (77.6)
	B	Carbon steel	1	1	...	50.0 (345)	...	...	12.5 (86.2)
	C	Carbon steel	1	1	...	55.0 (380)	...	...	13.8 (94.8)
SA-455	...	Carbon steel	1	2	...	75.0 (515)	...	(2)	18.8 (129.0)
SA-455	...	Carbon steel	1	2	...	73.0 (505)	...	(3)	18.3 (126.0)
SA-455	...	Carbon steel	1	2	...	70.0 (485)	...	(4)	17.5 (121.0)
SA-285 Modified to Chem.			...	...	...	...	...	(5)	...
AISI C-1012	...	0.10C to 0.15C	1	1	...	45.0 (310)	...	...	11.3 (77.6)
AISI C-1015d	...	0.13C to 0.18C	1	1	...	50.0 (345)	...	...	12.5 (86.2)
AISI C-1023	...	0.20C to 0.25C	1	1	...	55.0 (380)	...	...	13.8 (94.8)
SA-515	60	Carbon steel	1	1	CS-2	60.0 (415)	32.0 (220)	...	15.0 (103.0)
	65	Carbon steel	1	1	CS-2	65.0 (450)	35.0 (240)	...	16.3 (112.0)
	70	Carbon steel	1	2	CS-2	70.0 (485)	38.0 (260)	...	17.5 (121.0)
SA-516	55	Carbon steel	1	1	CS-2	55.0 (380)	30.0 (205)	...	13.8 (94.8)
	60	Carbon steel	1	1	CS-2	60.0 (415)	32.0 (220)	...	15.0 (103.0)
	65	Carbon steel	1	1	CS-2	65.0 (450)	35.0 (240)	...	16.3 (112.0)
	70	Carbon steel	1	2	CS-2	70.0 (485)	38.0 (260)	...	17.5 (121.0)
Sheet									
SA-414	A	Carbon steel	1	1	...	45.0 (310)	...	...	11.3 (77.6)
	B	Carbon steel	1	1	...	50.0 (345)	...	...	12.5 (86.2)
	C	Carbon steel	1	1	...	55.0 (380)	...	...	13.8 (94.8)
	D	Carbon steel	1	1	...	60.0 (415)	...	...	15.0 (103.0)
	E	Carbon steel	1	1	...	65.0 (450)	...	...	16.3 (112.0)
	F	Carbon steel	1	2	...	70.0 (485)	...	...	17.5 (121.0)
	G	Carbon steel	1	2	...	75.0 (515)	...	(5)	18.8 (129.0)
SA-414 Modified to Chem.									
AISI C-1012	...	0.10C to 0.15C	1	1	...	45.0 (310)	...	...	11.3 (77.6)
AISI C-1015	...	0.13C to 0.18C	1	1	...	50.0 (345)	...	...	12.5 (86.2)
AISI C-1023	...	0.20C to 0.25C	1	1	...	55.0 (380)	...	...	13.8 (94.8)
Forging(s)									
SA-105	...	Forging carbon steel	1	2	...	70.0 (485)	...	...	17.5 (121.0)
SA-181	Class 60	Forging carbon steel	1	1	...	60.0 (415)	...	...	15.0 (103.0)
SA-181	Class 70	Forging carbon steel	1	2	...	70.0 (485)	...	...	17.5 (120.7)
Pipe									
SA-53	A	Smls. carbon steel	1	1	...	48.0 (330)	...	...	12.0 (82.7)
SA-53	B	Smls. carbon steel	1	1	...	60.0 (415)	...	...	15.0 (103.0)
SA-106	A	Smls. carbon steel	1	1	...	48.0 (330)	...	...	12.0 (82.7)

A08

TABLE HLW-300
MAXIMUM ALLOWABLE STRESS VALUES IN TENSION FOR LINED WATER HEATER MATERIALS, ksi (MPa) (CONT'D)

Spec. No.	Grade	Nominal Composition	P-No.	Group No.	External Pressure Chart	Spec. Min. Tensile Strength, ksi (MPa)	Spec. Min. Yield Strength, ksi (MPa)	Note(s)	Max. Allow. Stress Value, ksi (MPa)
SA-106	B	Smls. carbon steel	1	1	...	60.0 (415)	...	...	15.0 (103.0)
SA-106	C	Smls. carbon steel	1	2	...	70.0 (485)	...	...	17.5 (121.0)
SA-53	A	ERW carbon steel	1	1	...	48.0 (330)	...	(6)	10.2 (70.3)
SA-53	B	ERW carbon steel	1	1	...	60.0 (415)	...	(6)	12.8 (87.9)
SA-135	A	ERW carbon steel	1	1	...	48.0 (330)	...	(6)	10.2 (70.3)
SA-135	B	ERW carbon steel	1	1	...	60.0 (415)	...	(6)	12.8 (87.9)
Tube									
SA-178	A	ERW carbon steel	1	1	...	47.0 (325)	...	(6)(7)	10.0 (68.9)
SA-178	C	ERW carbon steel	1	1	...	60.0 (415)	...	(6)	12.8 (87.9)
SA-513	1008	ERW carbon steel	1	1	...	42.0 (290)	...	(6)(7)(8)	8.9 (61.5)
SA-513	1010	ERW carbon steel	1	1	...	45.0 (310)	...	(6)(7)(8)	9.6 (65.9)
SA-513	1015	ERW carbon steel	1	1	...	48.0 (330)	...	(6)(7)(8)	10.2 (70.3)
Bars									
SA-36	...	Carbon steel	1	1	...	58.0 (400)	...	(9)(1)	14.5 (100.0)
SA-675	45	Carbon steel	1	1	...	45.0 (310)	...	...	11.3 (77.6)
	50	Carbon steel	1	1	...	50.0 (345)	...	...	12.5 (86.2)
	55	Carbon steel	1	1	...	55.0 (380)	...	...	13.8 (94.8)
	60	Carbon steel	1	1	...	60.0 (415)	...	...	15.0 (103.0)
	65	Carbon steel	1	1	...	65.0 (450)	...	...	16.3 (112.0)
	70	Carbon steel	1	2	...	70.0 (485)	...	...	17.5 (121.0)
Castings									
SA-278	20	Gray iron	...	...	...	20.0 (138)	...	(10)	...
	25	Gray iron	...	...	...	25.0 (173)	...	(10)	...
	30	Gray iron	...	...	...	30.0 (207)	...	(10)	...
	35	Gray iron	...	...	...	35.0 (242)	...	(10)	...
	40	Gray iron	...	...	...	40.0 (276)	...	(10)	...

GENERAL NOTES:

(a) Nonferrous material, if utilized for connections, etc., shall be in accordance with Table HF-300.2.

(b) To convert from ksi to MPa, multiply by 6.895.

NOTES:

(1) SA/CSA-G40.21, as specified in Section II, Part A, grade 38W or 44W may be used in lieu of SA-36 for plates and bars not exceeding $\frac{3}{4}$ in. (19 mm) for use at the same maximum allowable stress values as SA-36.

(2) For thickness up to $\frac{3}{8}$ in. (10 mm), incl.

(3) For thickness over $\frac{3}{8}$ in. to 0.580 in. (10 mm to 15 mm), incl.

(4) For thickness over 0.580 in. to 0.750 in. (15 mm to 19 mm), incl.

(5) For use only as shell plates, heads, tubesheets, or other surfaces to be glass lined.

(6) The stress value includes a joint factor of 0.85.

(7) Tensile value is expected minimum.

(8) This tube is restricted to use in glass lined water heaters.

(9) These allowable stress values apply also to structural shapes.

(10) Welding or brazing is not permitted.

A08

TABLE HLW-301
MAXIMUM ALLOWABLE STRESS VALUES IN TENSION FOR UNLINED WATER HEATER MATERIALS
ksi (MPa)

Spec. No.	Grade	Nominal Composition	P-No.	Group No.	External Pressure Chart	Spec. Min. Tensile Strength, ksi (MPa)	Spec. Min. Yield Strength, ksi (MPa)	Note(s)	Max. Allowable Design Stress, ksi (MPa) (See HLW-303)	
									Standard	Alternative [See Note (8)]
Plate Alloy Steel										
SA-240	304	18Cr–8Ni	8	1	HA-1	75.0 (515)	30.0 (205)	(1)(2)(3)	16.7 (114.0)	17.8 (122.0)
	304L	18Cr–8Ni	8	1	HA-3	70.0 (485)	25.0 (170)	(1)(2)(3)	14.3 (98.4)	16.5 (114.0)
	316	16Cr–12Ni–2Mo	8	1	HA-2	75.0 (515)	30.0 (205)	(1)(2)(3)	17.7 (119.0)	18.8 (129.0)
	316L	16Cr–12Ni–2Mo	8	1	HA-4	70.0 (485)	25.0 (170)	(1)(2)(3)	14.1 (97.8)	16.7 (115.0)
	439	18Cr–Ti	7	2	. . .	60.0 (415)	30.0 (205)	(4)(2)(5)	16.3 (103.0)	. . .
	S44400	18Cr–2Mo	7	2	CS-2	60.0 (415)	40.0 (275)	(4)(1)(5)	15.0 (103.0)	. . .
Tube Alloy Steel										
SA-213	TP304	Smls. 18Cr–8Ni	8	1	HA-1	75.0 (515)	30.0 (205)	(1)(2)(3)	16.7 (114.0)	17.8 (122.0)
	TP304L	Smls. 18Cr–8Ni	8	1	HA-3	70.0 (485)	25.0 (170)	(1)(2)(3)	14.3 (98.4)	16.5 (114.0)
	TP316	Smls. 16Cr–12Ni–2Mo	8	1	HA-2	75.0 (515)	30.0 (205)	(1)(2)(3)	17.7 (119.0)	18.8 (129.0)
	TP316L	Smls. 16Cr–12Ni–2Mo	8	1	HA-4	70.0 (485)	25.0 (170)	(1)(2)(3)	14.1 (97.8)	16.7 (115.0)
SA-249	TP304	Wld. 18Cr–8Ni	8	1	HA-1	75.0 (515)	30.0 (205)	(1)(2)(3)(6)	14.2 (97.1)	15.1 (104.0)
	TP304L	Wld. 18Cr–8Ni	8	1	HA-3	70.0 (485)	25.0 (170)	(1)(2)(3)(6)	11.9 (83.6)	14.0 (96.8)
	TP316	Wld. 16Cr–12Ni–2Mo	8	1	HA-2	75.0 (515)	30.0 (205)	(1)(2)(3)(6)	15.0 (101.0)	16.0 (110.0)
	TP316L	Wld. 16Cr–12Ni–2Mo	8	1	HA-4	70.0 (485)	25.0 (170)	(1)(2)(3)(6)	12.0 (83.1)	14.2 (97.7)
SA-268	TP439	Smls. 18Cr–Ti	7	2	CS-2	60.0 (415)	30.0 (205)	(4)(2)(5)	15.0 (103.0)	. . .
	S44400	Smls. 18Cr–2Mo	7	2	CS-2	60.0 (415)	40.0 (275)	(4)(1)(5)	15.0 (103.0)	. . .
	S44400	Wld. 18Cr–2Mo	7	2	CS-2	60.0 (415)	40.0 (275)	(4)(1)(5)(3)(6)	12.8 (88.3)	. . .
	S44735	Smls. 29Cr–4Mo	10J	1	CS-2	75.0 (515)	60.0 (415)	(7)	18.4 (127.0)	. . .
	S44735	Wld. 29Cr–4Mo	10J	1	CS-2	75.0 (515)	60.0 (415)	(6)(7)	15.5 (107.0)	. . .
Bar Alloy Steel										
SA-479	304	18Cr–8Ni	8	1	. . .	75.0 (515)	. . .	(1)(2)(3)	16.7 (114.0)	17.8 (122.0)
	304L	18Cr–8Ni	8	1	. . .	70.0 (485)	. . .	(1)(2)(3)	14.3 (98.4)	16.5 (114.0)
	316	16Cr–12Ni–2Mo	8	1	. . .	75.0 (515)	. . .	(1)(2)(3)	17.7 (119.0)	18.8 (129.0)
	316L	16Cr–12Ni–2Mo	8	1	. . .	70.0 (485)	. . .	(1)(2)(3)	14.1 (97.8)	16.7 (115.0)
	439	18Cr–Ti	7	2	. . .	70.0 (485)	. . .	(4)(2)(5)	16.6 (114.0)	. . .
	S44400	18Cr–2Mo	7	2	. . .	60.0 (415)	. . .	(4)(1)(5)	15.0 (103.0)	. . .
Pipe Alloy Steel										
SA-312	TP304	Smls. 18Cr–8Ni	8	1	HA-1	75.0 (515)	30.0 (205)	(1)(2)(3)	16.7 (114.0)	17.8 (122.0)
	TP304	Wld. 18Cr–8Ni	8	1	HA-1	75.0 (515)	30.0 (205)	(1)(2)(3)(6)	14.2	15.1 (98.0)
	TP304L	Smls. 18Cr–8Ni	8	1	HA-3	70.0 (485)	25.0 (170)	(1)(2)(3)	14.3 (98.4)	16.5 (114.0)
	TP304L	Wld. 18Cr–8Ni	8	1	HA-3	70.0 (485)	25.0 (170)	(1)(2)(3)(6)	12.2	14.0 (0.0)

A08

TABLE HLW-301
MAXIMUM ALLOWABLE STRESS VALUES IN TENSION FOR UNLINED WATER HEATER MATERIALS
ksi (MPa)(CONT'D)

Spec. No.	Grade	Nominal Composition	P-No.	Group No.	External Pressure Chart	Spec. Min. Tensile Strength, ksi (MPa)	Spec. Min. Yield Strength, ksi (MPa)	Note(s)	Max. Allowable Design Stress, ksi (MPa) (See HLW-303)	
									Standard	Alternative [See Note (8)]
Pipe										
Alloy Steel										
SA-312	TP316	Smls. 16Cr–12Ni–2Mo	8	1	HA-2	75.0 (515)	30.0 (205)	(1)(2)(3)	17.7 (119.0)	18.8 (129.0)
	TP316	Wld. 16Cr–12Ni–2Mo	8	1	HA-2	75.0 (515)	30.0 (205)	(1)(2)(3)(6)	15.0 (84.0)	16.0 (83.0)
	TP316L	Smls. 16Cr–12Ni–2Mo	8	1	HA-4	70.0 (485)	25.0 (170)	(1)(2)(3)	14.1 (97.8)	16.7 (115.0)
	TP316L	Wld. 16Cr–12Ni–2Mo	8	1	HA-4	70.0 (485)	25.0 (170)	(1)(2)(3)(6)	12.0 (83.1)	14.2 (0.0)
Forgings										
Alloy Steel										
SA-182	F304	18Cr–8Ni	8	1	HA-1	75.0 (515)	30.0 (205)	(1)(2)(3)	16.7 (114.0)	17.8 (122.0)
	F304L	18Cr–8Ni	8	1	HA-3	70.0 (485)	25.0 (170)	(1)(2)(3)	14.3 (98.4)	16.5 (114.0)
	F316	16Cr–12Ni–2Mo	8	1	HA-2	75.0 (515)	30.0 (205)	(1)(2)(3)	17.7 (119.0)	18.8 (129.0)
	F316L	16Cr–12Ni–2Mo	8	1	HA-4	70.0 (485)	25.0 (170)	(1)(2)(3)	14.1 (97.8)	16.7 (115.0)

GENERAL NOTE: To convert from ksi to MPa, multiply by 6.895.

NOTES:

(1) The maximum thickness is ½ in. (12.7 mm).

(2) The service temperature shall not exceed 210°F (99°C).

(3) Water heaters using this material are to be operated only on deionized water having a minimum specific resistivity of 1.0 MΩ/cm.

(4) The maximum is ⅜ in. (10 mm).

(5) Filler metal shall be Type 430 with a nominal molybdenum content of approximately 2%. The 300 series of chromium–nickel–iron filler metals shall not be used in welding vessels conforming to the requirements of Section IV.

(6) The stress value includes a joint factor of 0.85.

(7) Heat treatment after forming or fabrication is neither required nor prohibited.

(8) Due to the relatively low yield strength of the austenitic stainless steel materials, these higher stress values were established at temperatures at which the short time tensile properties govern to permit the use of these alloys where slightly greater deformation is acceptable. These higher stress values exceed two-thirds but do not exceed 90% of the yield strength at temperature. Use of these stress values may result in dimensional changes due to permanent strain. These stress values are not recommended for flanges of gasketed joints or other applications where slight amounts of distortion can cause leakage or malfunction.

where

E = efficiency of longitudinal joint or ligament between tube holes, whichever is less. For welded joints, use the efficiency specified in HLW-402. For seamless shells, use $E = 1$.

P = maximum allowable working pressure, psi (kPa) (but not less than 100 psi)

R = inside radius of cylinder, in. (mm)

S = maximum allowable stress value from Tables HLW-300, HLW-301, HF-300.1, and HF-300.2, psi (MPa)

t = required wall thickness, exclusive of liner, in.

HLW-305 BLANK UNSTAYED DISHED HEADS, PRESSURE ON CONCAVE SIDE

HLW-305.1 General. When the provisions of HLW-501 to HLW-504 are not used, the required thickness at the thinnest point after forming of ellipsoidal and torispherical heads under pressure on the concave side (plus heads) shall be computed by the appropriate formulas in this paragraph.

(a) Notations. The notations used in this paragraph are defined as follows:

D = inside diameter of the head skirt; or inside length of the major axis of an ellipsoidal head; or inside diameter of a cone head at the point under consideration, measured perpendicular to the longitudinal axis, in. (mm)

E = lowest efficiency of any joint in the head; use the efficiency specified in HLW-402. For seamless heads, use $E = 1$.

L = inside spherical or crown radius, in. (mm)

P = maximum allowable working pressure, psi (kPa) [but not less than 100 psi (700 kPa)]

MANDATORY APPENDIX 2
CODES, STANDARDS, AND SPECIFICATIONS REFERENCED IN TEXT

2-100 REFERENCE STANDARDS

Specific editions of standards incorporated in this Code are shown in Table 2-100. It is not practical to refer to a specific edition of each standard throughout the Code text, so edition references are centralized here. Table 2-100 will be revised at intervals and reissued as needed.

2-200 ORGANIZATIONS

Listed below are the names, acronyms, and addresses of specific organizations referred to in this Code.

American National Standards Institute (ANSI), 25 West 43rd Street, New York, NY 10036

American Society for Testing and Materials (ASTM), 100 Barr Harbor Drive, West Conshohocken, PA 19428

American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE), 1791 Tullie Circle, NE, Atlanta, GA 30329

CSA International (CSA), 178 Rexdale Boulevard, Toronto, Ontario, Canada M9W 1R3; 8501 East Pleasant Valley Road, Cleveland, OH 44131

National Fire Protection Association International (NFPA), 1 Batterymarch Park, Quincy, MA 02269

National Sanitation Foundation International (NSFI), 789 Dixboro Road, Ann Arbor, MI 48113

Underwriters Laboratories, Inc. (UL), 333 Pfingsten Road, Northbrook, IL 60062

TABLE 2-100 **A08**
CODES, STANDARDS, AND SPECIFICATIONS REFERENCED IN TEXT

	American National Standards
B16.1-1989	Cast Iron Pipe Flanges and Flanged Fittings
B16.5-1988	Pipe Flanges and Flanged Fittings
B16.9-1986	Factory-Made Wrought Steel Buttwelding Fittings
B16.11-1991	Forged Fittings, Socket Welding and Threaded
B16.15-1985	Cast Bronze Threaded Fittings
B16.24-1991	Cast Copper Alloy Pipe Flanges and Flanged Fittings
B16.28-1986	Wrought Steel Buttwelding Short Radius Elbows and Returns
B16.42-1987	Ductile Iron Pipe Flanges and Flanged Fittings
QAI-1	Qualifications for Authorized Inspection
	ASME Performance Test Code
PTC 25-2001	Pressure Relief Devices
	National Sanitation Foundation International (NSFI) Standard
ANSI/NSFI 14-1990	Plastic Piping Components and Related Materials
	Underwriters Laboratories Standard for Safety
UL 353-1994	Standard for Safety Limit Controls
UL 969-1995	Marking and Labeling Systems

GENERAL NOTE: The issue date, shown immediately following the hyphen after the number of the standard, is the effective date of issue (edition) of the standard.

MANDATORY APPENDIX 3
ADHESIVE ATTACHMENT OF NAMEPLATES TO CASING

3-100 SCOPE

The rules in Appendix 3 cover minimum requirements for nameplates and for the use of adhesive systems for the attachment of nameplates to casing, limited to

(a) the use of pressure-sensitive acrylic adhesives preapplied by the nameplate manufacturer and protected with a moisture stable release liner

(b) use of the preapplied adhesive within 2 years of its application

(c) use of an application procedure qualified as outlined in 3-101

3-101 NAMEPLATE APPLICATION PROCEDURE QUALIFICATION

(a) Each nameplate manufacturer's construction shall be qualified in accordance with ANSI/UL 969, Marking and Labeling Systems, for a surface temperature rating greater than that achieved on the surface of the casing in the area where the nameplate is applied during operation. The exposure conditions shall be for high humidity or occasional exposure to water. In addition if the boiler or water heater is designed and marked for outdoor installation, indoor-outdoor qualification shall be obtained with a cold box temperature of −40°F (−40°C).

(b) Each lot or package of nameplates shall be marked with the adhesive application date.

(c) The manufacturer's quality control system shall define that written procedures, acceptable to the Authorized Inspector (or ASME Designee for cast iron boilers), for the application of adhesive backed nameplates shall be prepared and qualified. The application procedure qualification shall include the following essential variables:

(1) each nameplate manufacturer's material and construction, including thickness range, UL File No., and rated substrate temperature(s) and finish

(2) the maximum temperature achieved on the surface of the casing in the area at which the nameplate is applied

(3) cleaning requirements for the casing surface

(4) application temperature range and pressure technique

(i) Strength of Connection Elements (See HW-730.1)

(1) Fillet Weld in Shear

$$\frac{\pi}{2} \times d_{on} \times \text{weld leg} \times S_s = 1.57 \times 4.5 \times 0.337 \times 5{,}390$$

$$= 12{,}833 \text{ lb}$$

(2) Groove Weld in Tension

$$\frac{\pi}{2} \times d_{on} \times t \times S_t = 1.57 \times 4.5 \times 0.437 \times 8{,}140$$

$$= 25{,}100 \text{ lb}$$

(3) Nozzle Wall Shear

$$\frac{\pi}{2} \times \text{mean nozzle diam.} \times t_n \times S_n$$

$$= 1.571 \times 4.163 \times 0.337 \times 7{,}700$$

$$= 16{,}971 \text{ lb}$$

Possible paths of failure are

(a) through (1) and (2) above with a strength of 37,933 lb

(b) through (1) and (3) above with a strength of 29,804 lb

Both paths are stronger than the required strength of 7,035 lb.

NONMANDATORY APPENDIX E
TERMINOLOGY

A08 E-100 TERMS RELATING TO DESIGN

action, popping, or pop: the action of a safety or safety relief valve when it opens under steam pressure. The disk of the valve is designed so that the force of the steam lifting the disk is increased when the disk is lifted slightly off its seat. The increase in force accelerates the rising action of the disk to the wide open position at or near the opening pressure.

blowdown: the difference between the opening and closing pressures of a safety or safety relief valve.

boiler, automatically fired: a boiler equipped with a means of introducing heat or of causing fuel, whether solid, liquid, gaseous, or electric, to be introduced into the boiler or boiler furnace, the means being so regulated by the rate of flow, the generating pressure, or temperature of the boiler fluid or of a vessel or space being heated as to maintain a determined, desired condition within a designated tolerance.

boiler, electric, resistance heating element type: electric boilers of the resistance heating element type are either:

(a) of a design where the electric resistance element is directly attached to the external surface of the pressure vessel; or

(b) an immersed type where the electric resistance element is inserted through an opening in the pressure vessel so that the element is in direct contact with the water.

boiler, horizontal-return tubular: a firetube boiler consisting of a cylindrical shell, with tubes inside the shell attached to both end closures. The products of combustion pass under the bottom half of the shell and return through the tubes.

boiler, hot water heating: a boiler designed to heat water for circulation through an external space heating system.

boiler, hot water supply: a boiler used to heat water for purposes other than space heating.

boiler, modular: a steam or hot-water heating assembly consisting of a grouping of individual boilers called modules, intended to be installed as a unit, with no intervening stop valves between the modules, with a single inlet and a single outlet. Modules may be under one jacket or may be individually jacketed. The individual modules shall be limited to a maximum input of 400,000 Btu/hr (117 kW) (gas), 3 gph (11 L/h) (oil), or 115 kW (electric).

boiler, steam heating: a boiler designed to convert water into steam that is supplied to an external space heating system.

boiler, vacuum: a factory-sealed steam boiler that is operated below atmospheric pressure.

bottom blowoff valve: a valve or cock located in the bottom blowoff connection of a boiler that, when opened, permits free passage of scale and sediment during the blowoff operation.

column, fluid relief: that piping, connected to the top of a hot water heating boiler, which is provided for the thermal expansion of the water. It will connect to either an open or a closed expansion tank.

drain valve: a valve or cock located in a boiler connection that, when opened, will drain the lowest water space practicable.

electric boiler, submerged electrode type: a submerged electrode type electric boiler incorporates a design wherein two or more metallic electrodes are directly suspended in the boiler water. When a source of electric power is connected to the electrodes, current will flow between the electrodes and through the water, thus raising the temperature of the water to produce steam.

feedwater: water introduced into a boiler during operation. includes makeup and return condensate or return water.

flue: passage through which gases pass from the combustion chamber or furnace to the venting system.

furnace: that part of a boiler in which combustion of fuel takes place or in which primary furnace gases are conveyed.

gases, primary furnace: gases in a zone where the anticipated temperature of the gas exceeds 850°F (450°C).

joints, swing: threaded, flanged, welded, or brazed pipe and fittings so arranged that the piping system that they comprise, when connected to a boiler, can expand and contract without imposing excessive force on it.

makeup water: water introduced into the boiler to replace that lost or removed from the system.

pressure, accumulation test: that steam pressure at which the capacity of a safety, safety relief, or a relief valve is determined. It is $33^1/_3\%$ over the steam safety valve set pressure and 10% over the safety relief valve set pressure.

pressure, design: the pressure used in the design of a boiler for the purpose of calculating the minimum permissible thickness or physical characteristics of the different parts of the boiler.

INTENTIONALLY LEFT BLANK

the specimen shall then be considered substantially saturated. The difference between the substantially saturated weight and the dry weight shall be considered as the water absorbed when substantially saturated.

7.5 *2-h Boiling Water Immersion*— The conditioned specimens shall be placed in a container of boiling distilled water, and shall be supported on edge and be entirely immersed. At the end of 120 ± 4 min, the specimens shall be removed from the water and cooled in distilled water maintained at room temperature. After 15 ± 1 min, the specimens shall be removed from the water, one at a time, all surface water removed with a dry cloth, and the specimens weighed to the nearest 0.001 g immediately. If the specimen is $\frac{1}{16}$ in. (1.5 mm) or less in thickness, it shall be weighed in a weighing bottle.

7.6 *$\frac{1}{2}$-h Boiling Water Immersion*— For all thicknesses of materials having a relatively high rate of absorption, and for thin specimens of other materials which may show a significant weight increase in $\frac{1}{2}$ h the specimens shall be tested as described in 7.5, except that the time of immersion shall be reduced to 30 ± 1 min.

7.7 *Immersion at 120°F (50°C)*— The conditioned specimens shall be tested as described in 7.5, except that the time and temperature of immersion shall be 48 ± 1 h and 50 ± 1°C (122.0 ± 1.8°F), respectively, and cooling in water before weighing shall be omitted.

7.8 When data for comparison with absorption values for other plastics are desired, the 24-h immersion procedure described in 7.1 and the equilibrium value determined in 7.4 shall be used.

8. Reconditioning

8.1 When materials are known or suspected to contain any appreciable amount of water-soluble ingredients, the specimens, after immersion, shall be weighed, and then reconditioned for the same time and temperature as used in the original drying period. They shall then be cooled in a desiccator and immediately reweighed. If the reconditioned weight is lower than the conditioned weight, the difference shall be considered as water-soluble matter lost during the immersion test. For such materials, the water-absorption value shall be taken as the sum of the increase in weight on immersion and of the weight of the water-soluble matter.

9. Calculation and Report

9.1 The report shall include the values for each specimen and the average for the three specimens as follows:

9.1.1 Dimensions of the specimens before test, measured in accordance with 5.6, and reported to the nearest 0.001 in.,

9.1.2 Conditioning time and temperature,

9.1.3 Immersion procedure used,

9.1.4 Time of immersion (long-term immersion procedure only),

9.1.5 Percentage increase in weight during immersion, calculated to the nearest 0.01% as follows:

$$\text{Increase in weight, \%} = \frac{\text{wet wt} - \text{conditioned wt}}{\text{conditioned wt}} \times 100$$

9.1.6 Percentage of soluble matter lost during immersion, if determined, calculated to the nearest 0.01% as follows (Note 5):

$$\text{Soluble matter lost, \%} = \frac{\text{conditioned wt} - \text{reconditioned wt}}{\text{conditioned wt}} \times 100$$

NOTE 5: When the weight on reconditioning the specimen after immersion in water exceeds the conditioned weight prior to immersion, report "none" under 9.1.6.

9.1.7 The percentage of water absorbed, which is the sum of the values in 9.1.5 and 9.1.6, and

9.1.8 Any observations as to warping, cracking, or change in appearance of the specimens.

10. Precision and Bias

10.1 *Precision*— An interlaboratory test program was carried out using the procedure outlined in 7.1, involving three laboratories and three materials. Analysis of this data yields the following coefficients of variation (average of three replicates).

	Within Laboratories	Between Laboratories
Average absorption above 1% (2 materials)	2.33%	4.89%
Average absorption below 0.2% (1 material)	9.01%	16.63%

10.2 *Bias*— No justifiable statement on the bias of this test method can be made, since the true value of the property cannot be established by an accepted referee method.

A08

NONMANDATORY APPENDIX K
GUIDE TO INFORMATION APPEARING ON CERTIFICATE OF AUTHORIZATION

ITEM **DESCRIPTION**

① a. The name of the Manufacturer or Assembler.
b. The full street address, city, state or province, country, and zip code.

② This section describes the scope and limitations, if any, on use of the Code symbol stamps, as illustrated below by some examples of scope statements. Field site Certificate of Authorization applies to items that are fabricated or assembled at a field site and is not intended to apply to items at any shop location.

H Code Symbol Stamp

1. Heating boilers, except cast iron, at the above location only.
2. Heating boilers, except cast iron, at the above location only. (This authorization includes multiple duplicate heating boilers.)
3. Heating boilers, except cast iron, at the above location. (This authorization does not cover welding or brazing.)
4. Heating boilers, except cast iron, at the above location and field sites controlled by the above location.
5. Heating boilers, cast iron only, at the above location only. (Assembly)
6. Heating boilers, except cast iron at field sites controlled by the above location only.
7. Heating boilers, except cast iron, at the above location only. (This authorization includes multiple duplicate heating boilers and does not include welding or brazing.)
8. Heating boilers, cast iron only, at the above location only. (Foundry)
9. Heating boilers, cast iron only, at the above location only. (Foundry and Assembly)
10. Heating boilers, cast iron only, at the above location only. (Installation of nameplate only, does not include assembly and hydrostatic test.)
11. Heating boilers, cast aluminum only, at the above location only. (Assembly)
12. Heating boilers, cast aluminum only, at the above location only. (Foundry)
13. Heating boilers, cast aluminum only, at the above location only. (Foundry and Assembly)
14. Heating boilers, cast aluminum only, at the above location only. (Installation of nameplate only, does not include assembly and hydrostatic test)

HLW Code Symbol Stamp

1. Potable water heaters at the above location only.
2. Potable water heaters at the above location only. (This authorization includes multiple duplicate potable water heaters.)
3. Potable water heaters at the above location and field sites controlled by the above location.
4. Potable water heaters at the above location only. (This authorization does not cover welding or brazing.)
5. Potable water storage tanks at the above location only.

6. Potable water storage tanks at the above location only (This authorization includes multiple duplicate potable water storage tanks.)
7. Potable water storage tanks at the above location and field sites controlled by the above location.
8. Potable water storage tanks at the above location only. (This authorization does not cover welding or brazing.)
9. Potable water heaters and potable water storage tanks at the above location only.

INTENTIONALLY LEFT BLANK

NONMANDATORY APPENDIX L
GUIDE TO MANUFACTURER'S DATA REPORT FORMS

INTRODUCTION

The following pages are a guide for completing the Manufacturer's Data Report Forms. Forms and guides are keyed in the following manner:

① Circled numbers refer to the guide for required subject material.

1. Numbers without circles appearing in the guide material identify specific lines on the Manufacturer's Data Report Forms.

Any quantity to which units apply shall be entered on the Manufacturer's Data Report with the chosen units.

Forms appearing in this section may be obtained from the ASME Order Department, 22 Law Drive, Box 2300, Fairfield, NJ 07007-2300.

A08

INSTRUCTIONS FOR THE PREPARATION OF SECTION IV MANUFACTURER'S DATA REPORT FORMS

Any quantity to which units apply shall be entered on the Manufacturer's Data Report with the chosen units.

Applies to Form										
H-2	H-3	H-4	H-5	H-5A	H-6	HLW-6	HLW-7	HLW-8	Note No.	Instruction:
X	X	X	X	X	X	X	X	X	①	Name and address of manufacturer (i.e., maker of all components not covered by Partial Data Reports).
X	X	X	...	...	X	X	X	...	②	Name and address of purchaser and/or owner.
X	X	X	...	...	X	X	...	...	③	Name and address of location where unit is to be installed. If not known, so indicate (e.g., "not known — built for stock").
X	X	...	X	X	X	...	...	X	④	Show type or model of unit documented by this data report.
X	X	X	...	...	X	X	X	...	⑤	Identification of unit by applicable numbers. If intended for installation in Canada, indicate the Canadian design registration number and drawing number.
X	X	X	...	...	X	X	X	...	⑥	Year in which fabrication was completed in shop.
X	X	X	...	...	...	X	X	...	⑦	Date (year) of Section IV edition under which boiler or part was constructed.
X	X	X	...	...	...	X	X	...	⑧	Issue date of most recent addenda to Section IV under which boiler or part was constructed (e.g., "December 1997").
X	X	X	...	...	...	X	...	...	⑨	Code Case number, if applicable.
X	...	...	...	...	...	...	...	...	⑩	Show quantity and inside dimensions. If more than two shells or drums are used, enter data in line 14.
X	X	X	...	...	...	X	X	X	⑪	Show the complete ASME material specification number and grade as listed in the appropriate stress allowance table in Section IV (e.g., "SA-285-B") Exception: A specification number for a material not identical to an ASME Specification may be shown only if such material has been approved for Section IV construction by an ASME interpretation case ruling and provided the applicable case number is also shown.
X	...	...	...	...	...	X	X	...	⑫	Indicate type of joint(s).
X	...	...	...	...	...	X	X	...	⑬	Show joint efficiency for welded joints.
X	...	...	...	...	...	...	...	...	⑭	Show number of furnaces in boiler.
X	...	...	...	...	...	...	...	...	⑮	For cylindrical furnaces of the Adamson, ring-reinforced, and combined types, show total length only.
X	...	...	...	...	...	...	...	...	⑯	For stayed (firebox) type furnace, complete line 12 also.
X	...	...	...	...	...	...	...	...	⑰	If threaded, show diameter at root of thread.
X	...	...	...	...	...	...	...	...	⑱	Minimum cross-sectional area after deducting for telltale hole.
X	...	...	...	...	...	...	...	...	⑲	Maximum allowable working pressure for the stayed area calculated according to the rules contained in Part HG of Section IV.
X	...	...	...	...	...	...	...	...	⑳	Type of stay or brace (e.g., diagonal, gusset, girder, through, etc.).
X	...	...	...	...	...	...	...	...	㉑	Minimum cross-sectional area of the stay or brace multiplied by the number of stays or braces supporting the area under consideration.
X	...	...	...	...	...	...	...	...	㉒	See applicable paragraphs and figures in Part HG of Section IV.
X	...	...	...	...	...	...	...	...	㉓	List parts not covered elsewhere on the data report. If insufficient space, attach a supplementary sheet.
X	...	...	...	...	...	...	...	...	㉔	Tabulate data for parts listed on line 14.
X	X	X	...	...	...	X	...	...	㉕	Show data for main and auxiliary inlets and outlets, nozzles, inspection openings, safety valve openings, drains, and blowoffs. This does not apply to small openings for water column, controls, vents, etc.
X	X	X	...	...	...	...	...	...	㉖	Maximum allowable working pressure.
X	...	...	...	...	...	...	...	...	㉗	Show Section IV paragraph that applies to the weakest part of the unit as established by calculation or deformation test.
X	...	...	...	...	...	...	...	...	㉘	Boiler heating surface calculated in accordance with HG-403 of Section IV.

A08

INSTRUCTIONS FOR THE PREPARATION OF SECTION IV MANUFACTURER'S DATA REPORT FORMS (CONT'D)

Applies to Form									Note No.	Instruction:
H-2	H-3	H-4	H-5	H-5A	LH-6	HLW-6	HLW-7	HLW-8		
X	...	...	...	...	...	...	...	...	㉙	Hydrostatic pressure applied in accordance with HG-510 and witnessed by the Authorized Inspector.
X	X	...	...	...	...	X	X	...	㉚	To be completed when one or more components comprising the unit are furnished by others and certified by the applicable Partial Data Report(s).
X	X	X	X	X	X	X	X	X	㉛	The manufacturer's ASME Certificate of Authorization number and date of expiration of said authorization.
X	X	X	...	...	X	X	X	X	㉜	This line is to be completed and signed by an authorized representative of the manufacturer.
X	X	X	...	...	...	X	X	X	㉝	This certificate is to be completed by the Authorized Inspection Agency representative who performs the in-shop inspection.
X	X	X	...	...	...	X	X	X	㉞	To determine what goes in this space, you should be guided by the following: National Board stamped boilers and pressure vessels: After "and state or province" in the certification blocks — if the Inspector has a valid Certificate of Competency for the state or province where the manufacturer's shop is located, insert the name of that state or province. If the manufacturer is located in a non-Code jurisdiction, insert the name of the state or province where the inspector took his original examination to obtain his National Board Commission, provided that Certificate of Competency is still valid. If not, show the name of the state or province where he has a valid Certificate of Competency authorizing him to make the shop inspection. Boilers and pressure vessels stamped only ASME: Follow the above procedure. However, in this case do not list any National Board Commission number after the inspector's signature at the bottom of the block.
X	X	...	...	...	...	X	...	...	㉟	Indicate the data items covered on the applicable form by line numbers.
X	X	...	...	...	...	X	...	...	㊱	Indicate by line numbers those items furnished by others and for which the applicable Partial Data Reports have been examined.
X	X	X	...	...	X	X	X	X	㊲	The inspector's National Board Commission number and the state or province Certificate of Competency number must be shown when the boiler is stamped National Board. The inspector shall use his jurisdictional Certificate of Competency and National Board Commission number on Partial Data Report Forms. If the boiler or vessel is not to be registered with the National Board, the inspector shall use only his state or province Certificate of Competency number.
X	X	...	...	...	...	...	...	...	㊳	The assembler's ASME Certificate of Authorization number and date of expiration of said authorization.
X	X	...	...	...	...	...	...	...	㊴	This line to be completed, when applicable, and signed by an authorized representative of the organization responsible for field assembly of the boiler.
X	X	...	...	...	...	...	...	...	㊵	This certificate to be completed by the Authorized Inspection Agency representative who performs the field assembly inspection.
X	X	...	...	...	...	...	...	...	㊶	Indicate by line numbers from the applicable form those items inspected in the field that were not inspected in the shop.
X	X	X	...	...	...	X	X	X	㊷	Nominal thickness of plate.
...	X	X	...	...	...	...	...	...	㊸	Minimum thickness after forming.
...	X	X	...	...	...	...	...	...	㊹	Radius on concave side of dish.
...	X	X	...	...	...	...	...	...	㊺	Shop hydrostatic test, if any, applied to individual part prior to test applied to the assembled boiler (see lines 33 and 35).
...	X	X	...	...	...	...	...	...	㊻	This line for headers not covered as items 7 through 10. It is intended primarily for sectional headers on straight tube watertube boilers.

A08

INSTRUCTIONS FOR THE PREPARATION OF SECTION IV MANUFACTURER'S DATA REPORT FORMS (CONT'D)

Applies to Form										
H-2	H-3	H-4	H-5	H-5A	H-6	HLW-6	HLW-7	HLW-8	Note No.	Instruction:
...	X	X	...	...	...	X	X	...	㊼	Indicate shape as flat, dished, ellipsoidal, torispherical, or hemispherical.
...	X	X	...	...	...	...	...	...	㊽	Use inside dimensions for size.
...	X	X	...	...	...	...	...	...	㊾	Indicate shape as square, round, etc.
...	X	X	...	...	...	...	...	...	㊿	Outside diameter.
...	X	...	...	...	...	...	...	...	(51)	Minimum thickness of tubes.
...	X	X	...	...	...	...	...	...	(52)	Size.
...	X	X	...	...	...	...	...	...	(53)	Describe type as flanged, welding neck, etc.
...	...	X	...	...	...	...	X	...	(54)	Show name of part (e.g., steam drum, waterwall header).
...	...	X	...	...	...	...	X	...	(55)	Show data line number on applicable form for the named part.
X	X	X	...	...	...	X	X	...	(56)	Any additional information to clarify the report should be entered here.
...	...	...	X	X	...	...	...	...	(57)	List each individual section that makes up boiler assembly. Show pattern and/or part number for each section. Show drawing number for each section. Show metal thickness for each section as indicated on the drawings. List each section of the complete boiler.
...	...	...	X	X	...	...	...	...	(58)	Show bursting pressure of each section of boiler. Show thickness measured at the break or fracture of each section. Indicate weight of each section.
...	...	...	X	...	...	...	...	...	(59)	Indicate minimum specified tensile strength for the class of iron as set forth in Table HC-300.
...	...	...	X	X	...	...	...	...	(60)	Indicate sections of boiler that represent specimen test bars. Show results of each specimen tested (tensile strength).
...	...	...	X	...	...	...	...	...	(61)	Show maximum allowable working pressure as determined by Formula HC-402 and by values allowed by Formula HC-402.
...	...	...	X	X	...	...	...	X	(62)	The individual designated to conduct tests, the designated manufacturer's representative who witnesses test and date or dates on which destruction tests were conducted.
...	...	...	X	X	...	...	...	...	(63)	Designated responsible engineering head certifying the tests and date.
...	...	...	...	...	...	X	...	...	(64)	Show quantity and dimensions.
...	...	...	...	...	...	X	X	...	(65)	Type of lining, if applicable.
...	...	...	...	...	...	X	X	X	(66)	Maximum allowable working pressure established in accordance with HLW-300 or HLW-500 of Section IV.
...	...	...	...	...	...	X	X	...	(67)	Indicate maximum allowable input, ____________. For tanks used for storage, indicate "storage only."
...	...	...	...	...	...	X	X	...	(68)	Maximum temperature in accordance with HLW-300 of Section IV.
...	...	...	...	...	...	X	X	...	(69)	Hydrostatic pressure applied in accordance with HLW-505 of Section IV and witnessed by the Authorized Inspector.
...	...	...	...	...	...	...	...	X	(70)	Part of vessel yielding first should be indicated.
...	...	...	...	...	...	...	...	X	(71)	Pressure at which yielding occurs as evidenced by flaking of the brittle coating or by appearance of strain lines.
...	...	...	...	...	...	...	...	X	(72)	Show yield strength for each of the three specimens and average of the three.
...	...	X	...	...	...	...	X	...	(73)	This ID number is a unique identifying number for this form, which may be assigned by the Certificate Holder if desired.
X	X	X	...	...	...	...	...	...	(74)	Maximum water temperature.
...	...	...	...	...	X	...	...	...	(75)	Fill in information identical to that shown on the Data Report Form to which this sheet is supplementary.
...	...	...	...	X	...	...	...	...	(76)	Indicate minimum specified tensile strength for the aluminum alloy as set forth in table HF-300.2.
...	...	...	...	X	...	...	...	...	(77)	Show maximum allowable working pressure as determined by Formula HA-402.

07
A08

FORM H-5A MANUFACTURER'S MASTER DATA REPORT FOR BOILERS CONSTRUCTED FROM CAST ALUMINUM

As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section IV

1. Manufactured and certified by ______ ① ______
(name and address of manufacturer) (foundry identification)

2. Boiler type or model no. ______ ④ ______

3. Boiler section data: (57)

Section Designation (List Each Individual Section in Boiler Assembly)	Pattern and/or Part No.	Metal Thickness According to Drawing
(a)		
(b)		
(c)		
(d)		
(e)		

4. Boiler section bursting data: (58)

	Bursting Pressure, Metal Thickness Measured at Break or Fracture, and Weight of Section		
Section Designation	Test No. 1	Test No. 2	Test No. 3
(a)			
(b)			
(c)			
(d)			
(e)			

5. Minimum specified tensile strength ______ (76) ______.

6. Tensile strength of associated test bars: (60)

Section Designation	Bar for Test No. 1	Bar for Test No. 2	Bar for Test No. 3
(a)			
(b)			
(c)			
(d)			
(e)			

7. Specification no. of aluminum alloy ______

8. Maximum allowable working pressure of boiler[1] ______ (77) ______

[1] Determined by using formula in HA-402 and by selection of lowest values of bursting pressure from tests recorded in item 4 of this report.

(02/08)

FORM H-5A (Back)

9. Sketch of section with lowest bursting pressure (show location of failure)

10. Examination data: (62)

(a) Test engineer ______________________________
(name)

(b) Witness of test(s) ______________________________
(name)

(c) Date(s) of destruction tests ______________________________

____

____

11. Manufacturer's certification: (63)

Date ______________, ______

Certified to be true record

____
(name and title)

NOTE: Signature of designed responsible engineering head of the manufacturer must be notarized.

12. ASME Certificate of Authorization no. ____________ ㉛ ____________ to use the "H" symbol (cast aluminum).

Certificate expires ______________, ______

(02/07)

nearest 1°C. The examples in the table below were created by rounding to the nearest 5°C, with one exception:

Temperature, °F	Temperature, °C
70	20
100	38
120	50
150	65
200	95
250	120
300	150
350	175
400	205
450	230
500	260
550	290
600	315
650	345
700	370
750	400
800	425
850	455
900	480
925	495
950	510
1,000	540
1,050	565
1,100	595
1,150	620
1,200	650
1,250	675
1,800	980
1,900	1 040
2,000	1 095
2,050	1 120

A08 M-3 SOFT CONVERSION FACTORS

The following table of "soft" conversion factors is provided for convenience. Multiply the U.S. Customary value by the factor given to obtain the SI value. Similarly, divide the SI value by the factor given to obtain the U.S. Customary value. In most cases it is appropriate to round the answer to three significant figures.

U.S. Customary	SI	Factor	Notes
in.	mm	25.4	...
ft	m	0.3048	...
in.^{2}	mm^2	645.16	...
ft^2	m^2	0.09290304	...
in.^{3}	mm^3	16,387.064	...
ft^3	m^3	0.02831685	...
U.S. gal	m^3	0.003785412	...
U.S. gal	liters	3.785412	...
psi	MPa (N/mm^2)	0.0068948	Used exclusively in equations
psi	kPa	6.894757	Used only in text and for nameplate
psi	bar	0.06894757	...
ft-lb	J	1.355818	...
°F	°C	$\frac{5}{9}$ × (°F – 32)	Not for temperature difference
°F	°C	$\frac{5}{9}$	For temperature differences only
R	K	$\frac{5}{9}$	Absolute temperature
lbm	kg	0.4535924	...
lbf	N	4.448222	...
in.-lb	N·mm	112.98484	Use exclusively in equations
ft-lb	N·m	1.3558181	Use only in text
ksi$\sqrt{\text{in.}}$	MPa$\sqrt{\text{m}}$	1.0988434	...
Btu/hr	W	0.2930711	Use for boiler rating and heat transfer
lb/ft^3	kg/m^3	16.018463	...

NONMANDATORY APPENDIX N GUIDE TO MANUFACTURER'S CERTIFICATE OF CONFORMANCE FOR PRESSURE RELIEF VALVES

INTRODUCTION

The following pages are a guide for completing the Manufacturer's Certificate of Conformance Form HV-1.

① Circled numbers refer to the guide for required subject material.

1. Numbers without circles appearing in the guide material identify specific lines on the Manufacturer's Certificate of Conformance Form.

Forms appearing in this section may be obtained from the ASME Order Department, 22 Law Drive, Box 2300, Fairfield, NJ 07007-2300.

ASME Boiler and Pressure Vessel Code
SECTION IV

INTERPRETATIONS
Volume 58

Interpretations of the Code are distributed annually in July with the issuance of the edition and subsequent addenda. Interpretations posted in January at www.cstools.asme.org/interpretations are included in the July distribution. Interpretations of Section III, Divisions 1 and 2, are part of the update service to Section III, Subsection NCA.

Interpretations Volumes 54 through 56 were included with the update service to the 2004 Edition of the Code; Volume 57 is the first Interpretations volume to be included with the update service to the 2007 Edition.

Section	Vol. 57	Vol. 58	Vol. 59
I	7/07	7/08	
II-A	7/07	7/08	
II-B	...	...	
II-C	...	...	
II-D (Customary)	7/07	...	
II-D (Metric)	...	...	
III-NCA	7/07	7/08	
III-3	7/07	...	
IV	7/07	7/08	
V	7/07	7/08	
VI	...	...	
VII	...	...	
VIII-1	7/07	7/08	
VIII-2	7/07	7/08	
VIII-3	7/07	7/08	
IX	7/07	7/08	
X	...	7/08	
XI	7/07	7/08	
XII	...	...	

Copyright © 2008
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS
All rights reserved

INTERPRETATIONS
VOLUME 58 — SECTION IV

Replies to Technical Inquiries
January 1, 2007 Through December 31, 2007

FOREWORD

This publication includes all written interpretations issued between the indicated dates by the ASME Staff on behalf of the ASME Boiler and Pressure Vessel Committee in response to inquiries concerning interpretations of the ASME Boiler and Pressure Vessel Code. A contents is also included which lists subjects specific to the interpretations covered in the individual volume.

These interpretations are taken verbatim from the original letters, except for a few typographical and editorial corrections made for the purpose of improved clarity. In some instances, a review of the interpretation revealed a need for corrections of a technical nature. In these cases, a revised interpretation is presented bearing the original interpretation number with the suffix R and the original file number with an asterisk. Following these revised interpretations, new interpretations and revisions to them issued during the indicated dates are assigned interpretation number in chronological order. Interpretations applying to more than one Code Section appear with the interpretations for each affected Section.

ASME procedures provide for reconsideration of these interpretations when or if additional information is available which the inquirer believes might affect the interpretation. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME committee or subcommittee. As stated in the Statement of Policy in the Code documents, ASME does not "approve," "certify," "rate," or "endorse" any item, construction, proprietary device, or activity.

An interpretation applies either to the Edition and Addenda in effect on the date of issuance of the interpretation or the Edition and Addenda stated in the interpretation. Subsequent revisions to the Code may supersede the interpretation.

For detailed instructions on preparation of technical inquiries to the ASME Boiler and Pressure Vessel Committee, refer to Appendix 1.

SECTION IV

Subject	Interpretation	File No.
HG-515.2(f) and HLW-600.2(b)(7)	IV-07-02	07-186
HG-515.2(f) and HLW-600.2(b)(7)	IV-07-02R	07-1175
HG-621, Instruments, Fittings, and Controls	IV-07-06	07-1322
HG-705, Feedwater and Makeup Water Connections	IV-07-03	06-949
HG-709.2, Closed Heating Systems	IV-07-05	07-1227
Use of Secondary Heat Exchanger in Path of Boiler Exiting Flue Gases	IV-07-04	07-192

Interpretation: IV-07-02

Subject: HG-515.2(f) and HLW-600.2(b)(7)

Date Issued: February 7, 2007

File: 07-186

Question (1): Does the word "all" as used in para. HG-515.2(f), with regard to making certain that "all material" has the required thickness, refer to each piece?

Reply (1): Yes.

Question (2): Does the word "materials" as used in para. HLW-600.2(b)(7), with regard to making certain that "materials" have the required thickness, refer to each piece?

Reply (2): Yes.

Note: The above interpretation was reconsidered by the committee and revised as follows.

Interpretation: IV-07-02R

Subject: HG-515.2(f) and HLW-600.2(b)(7)

Date Issued: June 22, 2007

File: 07-1175

Question (1): Does the word "all" as used in para. HG-515.2(f), with regard to making certain that "all material" has the required thickness, refer to each piece?

Reply (1): Yes; however, the type and degree of examination are not specified in the Code. These details are established by the Manufacturer in the Quality Control System, subject to the Authorized Inspector's acceptance, considering such things as the material type, how the material is produced, its product form, and the information provided by the supplier.

Question (2): Does the word "materials" as used in para. HLW-600.2(b)(7), with regard to making certain that "materials" have the required thickness, refer to each piece?

Reply (2): Yes; however, the type and degree of examination are not specified in the Code. These details are established by the Manufacturer in the Quality Control System, subject to the Authorized Inspector's acceptance, considering such things as the material type, how the material is produced, its product form, and the information provided by the supplier.

Interpretation: IV-07-03

Subject: HG-705, Feedwater and Makeup Water Connections

Date Issued: April 5, 2007

File: 06-949

Question: Is a separate check valve necessary if a backflow preventer, with dual check valves and an atmospheric vent, is installed in the dedicated feedwater/makeup water line of a Section IV boiler?

Reply: No, provided the backflow preventer with dual check valves and an atmospheric vent has a minimum pressure rating at least equal to the pressure stamped upon the boiler, and the temperature rating of the backflow preventer, including all internal components, shall be not less than 250°F (120°C).

Interpretation: IV-07-04

Subject: Use of Secondary Heat Exchanger in Path of Boiler Exiting Flue Gases

Date Issued: April 10, 2007

File: 07-192

Question: Must an economizer or secondary heat exchanger installed in the flue of a coil-type boiler or water heater, after the boiler has been stamped, be constructed to the requirements of Section IV?

Reply: This is outside the scope of Section IV. The Jurisdictional Authority where the boiler or water heater is to be installed shall be consulted to determine the applicability of the Code.

Interpretation: IV-07-05

Subject: HG-709.2, Closed Heating Systems

Date Issued: October 29, 2007

File: 07-1227

Question (1): In HG-709.2 Closed Heating Systems, does "working pressure" mean maximum allowable working pressure (MAWP)?

Reply (1): No.

Question (2): Is an ASME Code Section IV hot water heating boiler considered to be part of the "system" as used in HG-709.2?

Reply (2): Yes.

Question (3): Would the MAWP of the ASME Code Section IV hot water heating boiler be considered as the minimum design pressure for the system?

Reply (3): This is beyond the scope of the Code.

Question (4): For an ASME Code Section IV hot water heating system where the boiler has an MAWP greater than 30 psi, must the expansion tank be constructed in accordance with Section VIII, Division 1 (or Section X) if the system does not actually "operate" above 30 psi although it is "designed to operate" above 30 psi?

Reply (4): No.

Interpretation: IV-07-06

Subject: HG-621, Instruments, Fittings, and Controls

Date Issued: October 29, 2007

File: 07-1322

Question (1): Is it acceptable under HG-621 to mount the temperature and pressure gages for steam or hot water boilers behind a door that can be easily opened without tools of any kind?

Reply (1): Yes, provided the gages are visible through an opening or openings at all times.

Question (2): If the door in Question (1) is acceptable, must it be transparent so that you can see both gages without opening the door?

Reply (2): Yes.

INTENTIONALLY LEFT BLANK